IDRC-242e

Research Methodology for Livestock On-Farm Trials

Proceedings of a workshop held at Aleppo, Syria, 25–28 March 1985

يحوي هذا الكتاب ملخصات باللغة العربية

CANADA

Proceedings Series

85-6056/

The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences, information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

© International Development Research Centre 1985
Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa, Canada

Nordblom, T.L.
Ahmed, A.K.H.
Potts, G.R.
International Center for Agricultural Research in the Dry Areas,
  Tabriz IR
IDRC, Ottawa CA

IDRC-242e

Research Methodology for Livestock On-Farm Trials : proceedings of a workshop held at Aleppo, Syria, 25-28 March 1985. Ottawa, Ont., IDRC, 1985. 313 p. : ill.

/Livestock/, /animal nutrition/, /on-farm research/, /research methods/ - /animal breeding/, /forage crops/, /feed/, /cattle production/, /appropriate technology/, /innovations/, /experiments/, /research programmes/, /conference report/, /list of participants/.

UDC: 636:001.5 ISBN: 0-88936-446-X

Microfiche edition available

Il existe également une édition française de cette publication.

هذا الكتيب متوفر باللغة العربية

IDRC-242e

Research Methodology for Livestock On-Farm Trials

Proceedings of a workshop held at Aleppo, Syria, 25–28 March 1985

Editors: Thomas L. Nordblom, Awad El Karim Hamid Ahmed,
and Gordon R. Potts

يحوي هذا الكتاب ملخصات باللغة العربية

Cosponsored by the
International Center for Agricultural Research in the Dry Areas
and the
International Development Research Centre

Abstract This document contains 12 studies describing methods used in the conduct of livestock on-farm trials (LOFTs), primarily in the Middle East/Africa regions. Also presented are five methodological summaries that reflect on main issues covered in the 12 studies and discussed at the LOFT workshop: (a) definition of research problems, (b) trial design for on-farm experimentation, (c) levels of farmer participation, (d) criteria for evaluation, and (e) future directions for LOFTs. The 40 authors and coauthors have worked in multidisciplinary teams as social and biological scientists conducting livestock research in direct cooperation with farmers. Animal classes (sheep, goats, beef, and dairy) and modes of production (farm, feedlot, and open range) differed across the studies, but all emphasized research methods used to test new technologies through LOFTs. There was consensus that LOFTs will never replace laboratory and on-station livestock research. Rather, LOFT is a complementary research mode that may be used to best advantage where questions revolve around livestock interactions with particular farming environments or on the acceptability of new livestock technologies by farmers.

Résumé Cet ouvrage présente 12 études qui décrivent les différentes méthodes de recherche utilisées essentiellement dans les régions du Moyent-Orient et de l'Afrique pour des essais d'alimentation sur le bétail. On présente aussi cinq résumés méthodologiques qui font écho aux principales questions soulevées dans les 12 études et discutées à l'atelier : (a) définition du problème, (b) choix d'un modèle d'expérimentation sur le terrain, (c) niveaux de participation des exploitants, (d) critères d'évaluation et (e) orientations pour l'avenir. Les 40 auteurs et coauteurs ont travaillé au sein d'équipes multidisciplinaires à titre de spécialistes des sciences sociales ou de biologie effectuant des recherches sur le bétail en collaboration directe avec des exploitants. Les systèmes de production animale (mouton, chèvre, boeuf, produits laitiers) et les modes de production (exploitation agricole, parc d'engraissement, grand pâturage) diffèrent d'une étude à l'autre mais portent surtout sur les méthodes de recherche utilisées pour mettre à l'essai de meilleures technologies d'élevage du bétail. Les auteurs et coauteurs étaient unanimes à l'effet que les essais d'alimentation sur le bétail ne remplaceraient jamais la recherche en laboratoire et la recherche appliquée sur le bétail. Ces essais constituent plutôt un mode de recherche complémentaire particulièrement utile lorsque des questions portent sur des interactions entre le bétail et des milieux d'exploitation particuliers ou sur l'acceptation de nouvelles technologies d'alimentation du bétail par les exploitants.

Resumen Este documento recoge 12 ponencias sobre los diversos métodos empleados en los experimentos con ganado en fincas (LOFT), principalmente en el Medio Oriente. Presenta además, cinco resúmenes metodológicos de los temas más importantes presentados en los 12 estudios, a saber : (a) definición del problema; (b) diseño de ensayos experimentales en fincas; (c) niveles de participación de los agricultores; (d) criterios de evaluación; y (e) perspectivas futuras. Los 40 autores y co-autores han trabajado en equipos multidisciplinarios como especialistas en ciencias biológicas y sociales, realizando investigación sobre ganado con la participación de los agricultores. Las clases de animales (ovino, caprino, ganado de carne o leche) y los modos de producción (campo abierto, parcela o hacienda) difieren en los estudios, pero todos hacen énfasis en los métodos de investigación empleados para someter a prueba las nuevas tecnologías mediante LOFT. También debemos señalar que hubo consenso general en cuanto a que los LOFT no reemplazarán nunca la investigación pecuaria hecha en las estaciones especializadas, pero se estuvo de acuerdo en que es un modo investigativo complementario que puede usarse con beneficio cuando los interrogantes se centran en torno a las interacciones del ganado con los medios agrícolas particulares o con la aceptación de las nuevas tecnologías por parte de los agricultores.

CONTENTS

Foreword 5

Introduction 9

Livestock On-Farm Trials 13

Survey and on-farm trials in private beef cattle finishing feedlots in the Khartoum area **Saad El Medani Ahmed, Tagel Sir Ahmed Mohamed, and Mahgoub Gaafar El Hag** 15

Feeding conserved forages to traditional cattle in the Nuba Mountains, Sudan **W. Trent Bunderson and Richard H. Cook** 41

Developmental approach to on-farm research: pilot project for improving small ruminant production in humid West Africa **Akwesi Atta-Krah** 65

Farmers' responses to three summer forages in the Nile Delta **I.M. Soliman, E.A. Khafagi, M.E. Saleh Youssef, M.K. Hathout, and A.A. Moussa** 83

On-farm trials with dual-purpose goats on small farms in Western Kenya **A.E. Sidahmed, J.F.M. Onim, A.W. Mukhebi, R.S. Shavulimo, A.J. De Boer, and H.A. Fitzhugh** 101

Design and implementation of in-herd/on-range trials: use of sentinel herds **B. Fadlalla and Richard H. Cook** 133

On-farm trials of mineral supplementation for small ruminants in West Java, Indonesia **J.E. van Eys, S. Silitonga S., I.W. Mathius, and W.L. Johnson** 153

On-farm trials with ammoniation of straw in Egypt **H. Yackout, M.K. Hathout, H. El Nouby, and T.J. Barker** 173

Irrigated summer forages for small dairy farms in the Rahad Agricultural Scheme (Sudan): on-farm trials **R.S. Modawi, A.Y.M. Nour, A.H. Ahmed, A.B. Mohamed, and A.E.S. Ibrahim** 191

On-farm trials in Northwestern Syria: testing the feasibility of annual forage legumes as grazing and conserved feed **Dennis Tully, Euan F. Thomson, Ronald Jaubert, and Thomas L. Nordblom** 209

Use of crossbred dairy cows as draft animals: experiences from the Ethiopian highlands **Guido Gryseels and Frank M. Anderson** 237

Beef production from Sudanese cattle fed diets based on agroindustrial by-products: trials in private feedlots **A.Y.M. Nour and F.A. Hamza** 259

Methodological Summaries 275

Definition of research problems **H.C. Knipscheer** 277

On-farm trial design **J.E. van Eys** 283

Levels of farmer participation **J.A. Kategile** 289

Criteria for evaluation **R.H. Cook** 297

Directions for future trials **Frank M. Anderson** 303

Participants 311

FOREWORD

Livestock have integral roles in most farming systems and use resources and crop residues that otherwise could not be used. The complexities of livestock integration often lead to difficulties in predicting the effects of proposed "improvements." New techniques may be tested in laboratory and research station environments with great efficiency and control, however, for promising research results to reach the goal of economical application by farmers, the path is filled with hazards. National research and extension programs have often found that farmers face practical constraints that make adoption of apparent "improvements" impossible or unprofitable.

Farm surveys, which look into the costs and constraints of target groups of farmers, are an invaluable means of providing information on which to base designs for research to meet national development goals. The results, however, of laboratory and on-station research, even when designed with the use of farm survey data, may still require on-farm testing before being recommended to farmers. Thus, livestock on-farm trials (LOFTs) are a complementary mode of research to bridge the gap between controlled laboratory work and the successful adoption of true improvements in livestock production.

The International Development Research Centre (IDRC) has supported individual livestock research projects in the Middle East and North Africa region since 1976, notably in Sudan, Egypt, and Tunisia. This research has been complementary and parallel to efforts in Latin America, East Africa, and Southeast Asia. IDRC and the International Center for Agricultural Research in the Dry Areas (ICARDA), working with national agricultural research programs in the Middle East/Africa region, found a number of national scientists who were convinced of the need to do some of their livestock work in direct cooperation with farmers.

The enthusiasm of these scientists, and the variety of approaches and terms they were using, gave rise to the idea of bringing them together to study methodological problems of common concern.

To enhance professional contacts between national scientists, previously working in virtual isolation of one another, the workshop participants were asked to document their methods in formal studies, each touching on the same methodological aspects in the context of their specific piece of livestock on-farm research. Multidisciplinary coauthorship was encouraged and was achieved in most of the studies. This added greatly to the value of the workshop even though, generally, only one author of each study actually was able to participate directly. The contributions of all coauthors are greatly appreciated.

As one of the workshop objectives, it was planned to develop summaries across presentations on each main methodological aspect to document the strengths, weaknesses, and potentials of LOFTs. Five discussant/synthesizers volunteered for these tasks, which involved reading the 12 studies and pulling together comments made during the discussion sessions on each. For these efforts, the synthesizers deserve special thanks, they are Hendrik Knipscheer, Jan van Eys, Jackson Kategile, Richard Cook, and Frank Anderson.

As a complementary mode of research, LOFT methods seem to have advantages where questions revolve around livestock interactions in a particular farming system or around the acceptability of new livestock technologies by farmers. Because of these advantages, LOFT methods are expected to be developed and used by increasing numbers of national research programs in the future. This expectation will move more quickly toward realization as more regional researchers and research administrators become aware of the potentials.

This volume of case studies and methodological discussions is published with the intention of facilitating the exposure of ideas and speeding up communication about LOFT methods between scientists in the Middle East/Africa region in particular. To further these purposes, abstracts of all 12 case studies and full texts of the methodological summaries are provided in the Arabic language in this volume. Awad El Karim Hamid Ahmed, the editor in charge of these translations, was kindly assisted by Mohamed Bakheit Said, Faik Bahhady, and Mahmoud Ogla of ICARDA, and Nabil Ibrahim Hassan of the Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD). Thanks are also due to Diah Mufti of ICARDA for typing several drafts in Arabic.

The collaboration of several scientists and institutions greatly contributed to the LOFT workshop and the realization of this publication. Euan Thomson of ICARDA greatly assisted the organizers in developing ideas for the workshop and reviewing draft papers. Special appreciation is also extended to James Riley, of the Western Sudan Agricultural Research Project (WSARP, Khartoum), for advice that was instrumental in the earliest definition of the LOFT workshop. Finally, support of the following international organizations in funding the participation of their staff is gratefully acknowledged: the Farming Systems Support Project (Florida, USA), the International Livestock Centre for Africa (Addis Ababa, Ethiopia), Winrock International (Arkansas, USA), WSARP, and the Small Ruminant-Collaborative Research Support Project (North Carolina State University/USAID, USA).

H.D. Zandstra, Director
Agriculture, Food and Nutrition
Sciences Division
IDRC

INTRODUCTION

This document is intended to facilitate the sharing of ideas and experiences of scientists working with national programs in the Middle East, Africa, and elsewhere who are interested in livestock on-farm trials (LOFTs) in direct cooperation with farmers. It comprises 12 case studies on particular research and five methodological summaries.

Authors of the 12 studies were asked to put their main emphases on how their LOFTs were designed, conducted, and evaluated. They were asked first to define their research problem, state why it was studied, and identify which group of farmers was affected. Authors were then asked to report specifically on the following aspects of their methods:

(a) Identification and selection of farmers and farm sites for research.

(b) Trial design: size of plots, numbers and classes of animals, and the time span of the research in the context of the annual production pattern.

(c) Ownership, protection, and day-to-day control of livestock and field plots.

(d) On-farm measurements: how were they taken, at what frequency, and by whom.

(e) Terms of compensation for cooperating farmers.

(f) How are farmers' reactions, observations, and opinions recorded and used.

(g) Logistics of on-farm research: labour, vehicles, and other equipment or input requirements.

Following the description of their methods, the authors were asked to state their results briefly, including the following points:

(a) The main research indications regarding comparisons of quantitative field measurements, results in economic terms, and farmers viewpoints on these. Can farmers profitably adopt the new practice?

(b) Directions for planning future trials, demonstrations or policy changes: how applicable are the results to an identified target group of farmers?

(c) The authors' reflections on the scope, location, cost, quality, and value of the research: what aspects can be improved and how?

The level of treatment given to these points naturally varied between the 12 studies as the research reported varied in purpose and scope.

The original intention of the workshop was to focus on LOFTs in the relatively narrow definition of experimentation in biological research involving farmers on their farms. Although a number of the studies addressed LOFTs in the context of this definition, others implied much broader definitions: demonstration of a livestock technology, a complete package of component livestock research focused on a particular livestock system, and the extension approach in which a technology is transferred to as many beneficiaries as possible. The range of definitions (specific or implied) found in the 12 studies indicates a research method in its early stages of development.

The 12 studies also demonstrate the wide scope of research problems and livestock production systems that may be approached with LOFTs. Two studies consider feeding trials in commercial cattle fattening lots (Ahmed et al. and Nour and Hamza). Two studies focus on new irrigated forage crops for cattle (Soliman et al. and Modawi et al.). Another two studies look at rainfed forage production and use (Bunderson and Cook and Tully et al.). Three studies deal with innovations in livestock uses, management, and experimental control: crossbred dairy cows for draft power in Ethiopia (Gryseels and Anderson), dual-purpose goats in western Kenya (Sidahmed et al.), and in-herd/on-range trials with sentinel herds of cattle in Sudan (Fadlalla and Cook). Finally, three studies report on the testing of new inputs to the farming system: alley farming with leguminous forage trees for goat feed in Nigeria (Atta-Krah); mineral supplementation of goats in west Java, Indonesia (van Eys et al.); and the ammoniation of straw for cattle in Egypt (Yackout et al.).

All of the 12 studies are based on research done in cooperation with farmers, on their land, using their labour and mostly their animals and feedstuffs. The LOFT practitioners have demonstrated considerable ingenuity and resourcefulness in both their field work and their documentation. They have had to improvise not only in conducting the research but in developing new terms and definitions to describe their work. In most cases, the research studies collected here were done in isolation of each other. Thus, the reader may find a lack of common terminology for features the studies actually have in common. These facts, again, are indicative of research techniques at an early stage of development.

In addition to bringing together 12 studies by scientists who have pioneered LOFT efforts in their respective countries, the workshop enabled a number of them to meet each other personally and discuss their ideas more fully. In general, however, only one co-author of each study participated in the workshop.

Five of the workshop participants agreed to take on the roles of discussant/synthesizers. Each of them had the task of carefully reading all of the 12 studies, acting as prime listeners in all the discussions, and leading smaller working groups in discussions on specific topics in LOFT methods. On the last day each reported on an agreed topic to the full workshop. Most of the studies touch on each of the five methodological topics, providing an excellent start for thoughtful and often lively discussions among the participants. Readers will benefit from the syntheses accomplished in the five summaries: (a) on the definition of research problems (Knipscheer), (b) on trial designs (van Eys), (c) on farmer participation in LOFTs (Kategile), (d) on criteria for evaluation (Cook), and (e) on future directions for LOFTs (Anderson).

Although there was diversity of opinion among the participants, there was a surprising degree of consensus on the usefulness of LOFTs in some applications, particularly those in which there are important interactions of a new technique with other features of the farming environment. In such cases, laboratory or research station experiments could give little information on the appropriateness of a new technology for a target farming system.

Another point of consensus was on the need for prescreening of new technologies before promoting them with farmers. The prescreening process can involve survey methods and diagnostic trials to learn current farm practices and existing conditions. It should also involve preliminary economic analysis using the best information at hand to estimate the potential profitability of the new technology from the farmers' viewpoint and its affect on the region. This would lead to an early focus on the best potential improvements in terms of individual benefits and regional impact.

There is a need for clearer definitions of research problems and more explicit statements of objectives. Depending on the particular objectives, LOFTs may be designed, conducted, and evaluated as legitimate parts of (a) diagnosis, (b) design, (c) testing, or (d) extension phases of a farming systems research and development process.

There was consensus that LOFTs will never replace laboratory or on-station livestock experimentation. Rather, LOFTs appear to be a complementary mode that, because of the effectiveness in approaching certain classes of problems (particularly those regarding questions of acceptability by farmers), promises to become a more common and even routine tool of national research programs in the future.

Thomas L. Nordblom, ICARDA
Awad El Karim Hamid Ahmed,
University of Gezira
Gordon R. Potts, IDRC

Livestock On-Farm Trials

SURVEY AND ON-FARM TRIALS IN PRIVATE BEEF CATTLE FINISHING FEEDLOTS IN THE KHARTOUM AREA

Saad El Medani Ahmed,[1] Tagel Sir Ahmed Mohamed,[2] and Mahgoub Gaafar El Hag[2]

[1]Department of Agricultural Economics, Faculty of Agriculture, and [2]Department of Animal Nutrition, Institute of Animal Production, University of Khartoum, P.O. Box 32, Khartoum North, Sudan

Abstract *The objective of this research was to introduce a cost-reducing technology through maximizing usage of agroindustrial by-products in beef finishing operations in the Sudan. Beef finishing in the Sudan is conventionally based on the use of high levels of costly concentrate feedstuffs with minimum by-products.*

Before the conduct of on-farm trials (OFTs) a reconnaissance survey covering all feedlots in the Khartoum area was conducted by a team of researchers (an agricultural economist and two animal nutritionists). The objectives of the survey were to help in understanding beef finishing in the Sudan and selecting sites for the OFT. Survey results were analyzed using simple mathematical techniques and descriptive statistics (mainly frequency distributions).

Based on the survey results and cooperation of feedlot owners, two sites were selected for OFT. Two pretested, by-product-based rations (25% on an as-fed basis of groundnut hulls and sorghum straw) were used with the conventional concentrate-based ration traditionally used by the feedlot owners. The design was a 3 x 10 complete random design. Trials were carried out for 67 days during the normal season (August-January 1985). Feed intake, animal performance, chemical composition, and cost of feeds, labour, and transportation were measured.

Results were analyzed statistically by the analysis of variance (ANOVA) and economically by partial budgeting and sensitivity analysis. Results clearly demonstrated the superiority of by-products over concentrate-based rations. Farmers were very cooperative and interested, and they participated significantly in the OFT.

Résumé *Le but d'une telle recherche était d'introduire, dans les opérations d'engraissement du boeuf au Soudan, une technologie qui permettrait de réduire les coûts en tirant le maximum des sous-produits agro-industriels. Dans ce pays, la fin d'engraissement du boeuf s'appuie habituellement sur l'usage de fortes quantités d'aliments concentrés coûteux, où entrent peu de sous-produits.*

Avant de faire des essais pratiques, une équipe de chercheurs (un économiste agricole et deux spécialistes de la nutrition animale) a mené, dans tous les parcs d'engraissement de la région de Khartoum, une enquête générale qui visait à comprendre le système de fin d'engraissement du bétail au Soudan et à choisir les sites des essais pratiques. On a analysé les résultats de l'enquête au moyen de techniques mathématiques simples et de statistiques descriptives (principalement la distribution de fréquence).

Les résultats de l'enquête et la collaboration des propriétaires de parcs d'engraissement ont permis de sélectionner deux sites pour les essais sur le terrain. Deux rations prétestées contenant des sous-produits (dont 25 % d'écales d'arachide et de paille de sorgho) ont été utilisées en même temps que la ration habituellement utilisée par les propriétaires de parcs. Les essais, organisés suivant la méthode des blocs aléatoires complets de 3 x 10, se sont déroulés pendant 67 jours au cours de la saison normale (août-janvier 1985). On a mesuré la consommation de nourriture, la performance animale, la composition chimique, ainsi que les coûts des aliments, de la main-d'oeuvre et du transport.

Les résultats furent analysés d'un point de vue statistique (analyse de la variance) et économique (établissement de budgets partiels) et soumis à une analyse de sensibilité. Il est apparu clairement que les rations à base de sous-produits étaient supérieures à celles à base de concentrés. Les agriculteurs ont offert une grande collaboration, se montrant intéressés et participant activement aux essais sur le terrain.

Arable and livestock farming in Sudan are managed separately with mixed farming practiced on a very limited scale around irrigated and some rainfed cultivation areas. Livestock raised under this system are alternatively fed on natural pastures and postharvest crop residues. The other main systems of livestock husbandry include nomadism and intensive or zero grazing systems. The former depends completely on the least reliable method of natural pasture and range grazing for feeding. Beef cattle cover considerable distances (350-700 km) before they reach the finishing feedlots near the major consumer centres and export terminals. In these feedlots, animals are "finished" on purchased feeds, mainly concentrates.

In recent years, natural pastures and rangelands[1] have been endangered considerably by development strategies, emphasizing expanding arable farming by opening grazing areas for cultivation, and by the continued deforestation and desert creep. In spite of this, little use has been made by the livestock sector of the 8.8×10^6 t (11% of available feeds) of agricultural by-products resulting from arable farming. This limited use in the traditional areas of production may be partially explained by:

(a) The low livestock population density in most of the areas where these agricultural by-products are grown;

(b) Bulkiness of agricultural by-products, which adds to their cost of transportation;

(c) Availability of agricultural by-products in forms not suitable for direct use by animals; and

(d) Little knowledge about the nutritive values of agricultural by-products and the general ignorance about their feeding.

The explanation given for the limited use of agricultural by-products by the beef-finishing industry is not convincing. First, the finishing feedlots are within easy access of the major agricultural by-product producing areas. Second, 1.2 x 10^6 cattle[2] reach and stay for nearly 3 months in the finishing feedlots. Third, the price of concentrates conventionally used in finishing is rising and the concentrates used are estimated at about 70% of the total concentrates of 1 x 10^6 t used by all the Sudanese livestock sector.

---

[1] Natural pastures and rangelands make up about 85% of the nutrient requirements of the estimated 22×10^6 animal units in Sudan.

The most important concentrate used in beef-cattle finishing is dura (sorghum) grain, which is the basic diet of the Sudanese people and the major source of energy to other monogastric animals, particularly poultry. The ability of ruminants to digest agricultural by-products (cellulose and hemicellulose), which would otherwise be wasted; the severe competition they give humans and the expanding poultry industry in dura consumption; and the high cost of concentrates conventionally used in beef cattle finishing are ample justification for this research.

It is, therefore, our contention that considerable use can be made of the available agricultural by-products and with great cost effectiveness. It is also our contention that the response of beef cattle to finishing, especially the stressed animals (80% of the cattle travel on hoof for 35-70 days before they reach the finishing feedlots), on rations based on high levels of agricultural by-products could be comparable to that obtained from concentrates. To test these hypotheses about the technical and economic efficiencies of agricultural by-product utilization requires detailed studies at the feedlot level. This is what the present research program, which started a year ago and is planned to continue for 2 more years, is investigating. In addition to introducing a cost-reducing technology, this research attempts to achieve the following specific objectives:

(a) To examine and understand the operations of the beef cattle finishing industry in the Khartoum area;

(b) To examine the response of animals to different on-station-tested rations, based on high levels of agricultural by-products, and to evaluate the financial implications of the corresponding change in the finishing regime;

---

[2] Representing about 60% of the national annual withdrawal of 2 x 10^6 cattle.

(c) To determine the least costly pattern and intensity of feeding in the beef cattle finishing industry; and

(d) To assess the possible ways of intervention into the system and conduct research directed toward the better formulation of feeding rations in accordance with feed composition, animal requirements, and production objectives.

The chief concern of this paper is to evaluate critically the methodology of livestock on-farm trials (LOFT) used in this research. The first section exposes the research problem and its economic importance. The second section examines the general on-farm research strategy followed. We then discuss the main components of this strategy, particularly initial data collection, planning, and implementation of on-farm trials, and reveal experiences gained and lessons learned about the improvement of on-farm research in livestock studies. In the final section, we discuss the major analytical techniques used and the main findings obtained so far.

RESEARCH STRATEGY

The introduction and adoption of agricultural by-products by the beef cattle finishing industry involves interactions between the biological and socioeconomic sciences and is influenced by other subsystems like input distribution, credit, transport, and other marketing functions and extension services. To explore these interactions and linkages, a multidisciplinary approach was followed.[3]

The strategy used for this research follows the sequence presented in Fig. 1 with every process being

---

[3] Three researchers, an agricultural economist, and two animal nutritionists, assisted by a number of postgraduate students, are involved in this research.

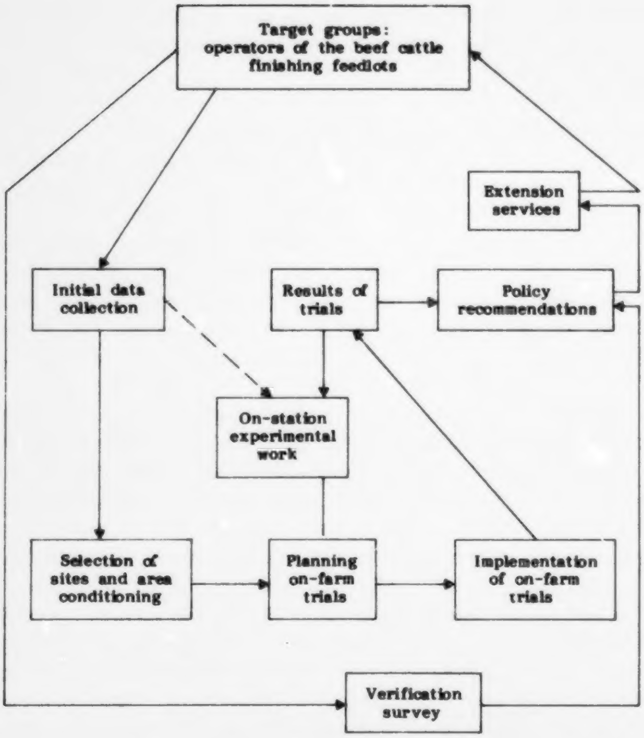

Target groups: operators of the beef cattle finishing feedlots
Extension services
Initial data collection
Results of trials
Policy recommendations
On-station experimental work
Selection of sites and area conditioning
Planning on-farm trials
Implementation of on-farm trials
Verification survey

Fig. 1. Research strategy.

built onto the information generated by the previous process(es). The strategy starts with arrangements for and collection of data needed for a quick preliminary understanding of the system, area conditioning, and selection of sites for LOFTs. This is followed by planning and preparations for LOFTs, including contacts with feedlot operators, design of trials, feed procurement, and preparation of feed and other logistics. With the start of the trials, data on the necessary attributes should be recorded according to the specified time schedule, and problems and deviations should be noted for quick monitoring of the project. Feedback from the trials can indicate if there are possibilities for intervention in the system and guide further on-station research with the developed rations tested under feedlot conditions. From the results of the trials and the results of a wider verification survey, policy constraints can be identified and policy recommendations needed to support the technology can be formulated. These can then be passed to the target groups via extension channels.

INITIAL DATA COLLECTION AND ANALYSIS

The experience of many researchers has shown that basic data collection can best be achieved by gathering secondary information followed by a reconnaissance survey. Information from secondary sources relating to the geographical spread of feedlots and their number and type is particularly useful in guiding data collection to some key variables and in reflecting upon the coverage of the reconnaissance survey, given the material and human resources that can be made available for this purpose.

The use of secondary data in organized farming situations with clear land tenure relationships can even extend to the selection and design of a suitable sampling procedure. With beef-cattle finishing feedlots in Sudan, however, land registers are rare, and most of the operators use the open space for their finishing activities. Therefore, the availability of useful secondary data was not expected.

Nevertheless, a list containing names of both dairy and beef cattle feedlot operators and the location of their feedlots was obtained from the Animal Production Administration in the Ministry of Agriculture. As expected, the list was inadequate in many respects, but it did help in guiding the researchers' movements in the first few days of the reconnaissance survey. Later on, asking farmers about the feedlots in their neighbourhood proved to be very useful. This was further facilitated by the location of most of the feedlots away from residential dwellings, which enabled visual inspection. Because of the lack of information about feedlots and their expected limited number, a reconnaissance survey of 100% coverage was conducted.

The questionnaire, which was jointly prepared by the biological and social scientists and used in this exploratory survey, is composed of a short list of topic themes covering both qualitative and quantitative aspects such as location, number of animals, rations used, housing, methods of feeding, main feed and disease problems, seasonality of operations and finishing periods, and other attributes related to the management of the feedlot. The questionnaire format was used in this survey without prior testing; however, our experience clearly demonstrated the importance of questionnaire pretesting because of (a) our continued insertion of useful information missed in the initial preparation of the format, and (b) our inability to use a coded format, which would be extremely useful in quick data recording and in storage and retrieval of data if computer facilities were available.

The survey was conducted entirely by the researchers who visited the feedlot to interview the operator or one of his skilled workers. Using a single-visit technique of data collection, 2-3 feedlots were visited every day and the survey took 1 month to complete. Apart from the researchers' time and one vehicle, no other major resources were used in this investigation.

There was no formal interviewing undertaken because our experience also showed that explaining the purpose of the research and the survey to the people being interviewed and giving them the opportunity to talk freely about the organization of their feedlots made the trouble of formal interviewing unnecessary, enriched the data collection, and saved time. Frequent interference by researchers may be needed to redirect the interview to important questions and to guard against wasting time. The time taken by each interview ranged between 30 min and 1 hour. The forms were filled in by one researcher with the researcher's personal impressions recorded separately. In addition to data collection, careful area conditioning for OFTs, as detailed later in this paper, was made and the willingness and cooperative spirit of the operators were also recorded. A note was also taken of the available facilities, such as balances, feeding and drinking troughs, stores, etc., that can be used for OFTs.

Analysis starts immediately after researchers leave the feedlot with the additional information gathered being recorded and the format to be used in subsequent visits adjusted as required. Following full coverage of the feedlots, the data were coded and stored in a computer for analysis. Simple data analysis based on descriptive statistics (frequency distribution and tabulation) satisfactorily delineated the basic features of the systems and generated most of the information needed for the design and conduct of the feedlot trials.

Beef Cattle Finishing Systems and Duration of Finishing

From the survey, two major systems that vary in their management, resource base, and orientation were identified. About two-thirds of the animals are finished by the traditional system and the remaining third by the semimodernized system (Table 1).

The 79 feedlots are scattered over an area of about 250 km^2 and are shared between the traditional (92%) and the semimodernized (8%) systems. In addition to better management of housing (Table 2), feeding and drinking facilities, veterinary services, and knowledge

Table 1. Distribution of feedlots and animals between different finishing systems.

System	Number of feedlots	Total number of animals	Number of animals per feedlot	
			Average	Range
Semimodernized	6	4440	740	200-1700
Traditional				
Mwielih	44	7312	168	25-2277
Other areas	29	1599	55	6-200
Total	79	13351	169	6-2277

Note: The survey was carried out in March - a period of reduced animal inflow to the finishing feedlots.

Table 2. Distribution of feedlots according to method of keeping animals.

Method	Number of feedlots	Percentage of total
Animal kept in the open	45	57
Thorny fence (Zariba)	11	14
Fence of junk cars	11	14
Open barns	9	11
Closed houses	3	4
Total	79	100

about finishing standards, the semimodernized system represents the fine end of the trade with the operators' activities directed toward export (on a contract basis - specifying quality and weight) or provision of high-quality meat to local consumers. The traditional beef cattle finishing system consists of a wide array of operators who differ mainly in the size of their businesses.

Although a good part of their animals are destined for the export market, the influence of the local market forces and the operators' holding powers, specifically on the duration of their finishing activities, are significant. All operators in the semimodernized system and 80% of those in the traditional system finish their animals for a period ranging from between 45 and 60 days (Table 3). The 8% of the traditional-system operators finishing their animals in less than 30 days are mainly butchers who generally keep less than 10 animals. Short finishing periods in this case are necessitated by the operators' slender reserves and need for a quick turnover to maintain the continuity of their business. In contrast, some of the well-to-do operators keep their animals for longer periods by regulating their finishing regimes in anticipation of the high summer prices of

Table 3. Distribution of feedlots according to duration of finishing (days).

Period (days)	Number of feedlots: Traditional No.	%	Semimodernized No.	%
15-30	6	8	-	-
45	19	26	2	33.3
50	11	15	2	33.3
60	28	39	2	33.3
70-80	8	11	-	-
90	1	1	-	-
Total	73	100	6	100

meat. Apart from the semimodernized feedlot operators who have registered fenced holdings, the feedlots of the other operators are scattered in the open.

Seasonality of Finishing

The beef-cattle finishing industry is a completely commercial undertaking based on finishing mature animals (4-6 years old). Two main seasons were identified: (a) animals reaching the feedlots after the rainy season (August-February) arrive in a relatively good condition because of the available pastures on their way from Western Sudan (the main source of beef cattle) and (b) animals arriving after February are stressed and in poor condition. Because of the deteriorating pastures, feed during this period is sometimes transported more than 100 km to feed animals on the way. Finishing the inflow of stressed animals continues until July.

Rations

Apart from the semimodernized feedlots that grow limited fodders, all feedlots depend almost exclusively on purchased concentrate feeds. Although agricultural by-products are used by all operators, the quantities fed are very small (less than 5% of the ration). The common ration used consists of cottonseed cake (40-50%), crushed sorghum grain (40-50%), by-products (5%) and salt (1%). Rations are either formulated, manufactured in pelleted or mesh form, or mixed on the farm. Pelleted rations are especially used by the operators in the semimodernized system. Different types of agricultural by-products are also used (Table 4). Their availability depends upon the seasonal nature of the production of the main products. Gassab (sorghum stalks) and groundnut hulls are used most commonly mainly because of their abundance and availability for longer periods.

PLANNING OF AND PREPARATION FOR OFTs

Selection of Sites

The selection of sites for OFTs is influenced by the target groups, the degree of variation among and within the systems, and by the resources available for carrying out the trials. Results of the reconnaissance survey clearly showed the dominance of and variation between the traditional and the semimodernized systems and revealed the high level of homogeneity, in terms of rations used, finishing practices, and general management of the feedlots within each system. This necessitated the representation of the two systems in the OFTs.

OFTs, however, are expensive and require continuous data recording, perhaps even on a daily basis for some attributes, and careful planning and monitoring. This would, naturally, influence the number of feedlots that can be selected from each system. Such a question can be approached either through the selection of more feedlots with a small number of animals included in the trials or, conversely, a relatively large number of animals within limited feedlots.

Although the former method, through its emphasis on wider coverage, improves representation of the system, it, nevertheless, greatly increases the demand on the available resources and may make the time spent on traveling even more limiting. It may also limit the number of treatments within each trial or, otherwise,

Table 4. Distribution of feedlots according to type of ration used.

Ration	Number of feedlots		Total	%
	Traditional	Semimodernized		
Cottonseed cake (CSC), dura, and gassab	63	1	64	81
CSC, dura, groundnut hull, and wheat bran	6	-	6	8
CSC, dura, and pelleted feeds	-	3	3	4
CSC and pelleted feeds	2	-	2	3
CSC, gassab, and wheat bran	1	-	1	1
Pelleted feeds and green fodder	-	1	1	1
Pelleted feeds, green fodder, and gassab	-	1	1	1
Gassab (sorghum stalks) only	1	-	1	1
Total	73	6	79	100

cause some statistical problems as often encountered in the analysis of very small samples.

Most of these drawbacks can be avoided if the second method of selection were used. Furthermore, the consolidation of efforts embodied in this method of selection is particularly emphasized because of the limited experience and scanty literature on the research methodology for LOFTs. Accordingly, two feedlots were selected for the OFTs; one in Western Omdurman (Mwielih area) to represent the traditional system and the second in Khartoum North (Halfaya area) to represent the semimodernized system.

Although all operators favourably responded to the proposed research program the selection of the individual operators was more influenced by their ability to provide, for both seasons, the required number of animals. The main cattle terminal market is situated in the Mwielih area and is supervised by a former student of the researchers. The selection of a feedlot from this system was also influenced by the supervisor's judgment on the most cooperative operator.

Contact with the Selected Operators

Following adequate area conditioning during the reconnaissance survey, the research objectives and methodology were further discussed, frankly and in great detail, with the selected feedlot operators. The importance of this approach has been thoroughly demonstrated by the operators' interest and willingness to promote the research program and by their desire to participate in the design and conduct of the OFTs. The research being designed and supervised by impartial bodies (the University of Khartoum and the International Development Research Centre (IDRC)) has been greatly appreciated by the operators. This, in addition to our provision of feeds, may have also helped in encouraging the operators' good responses and, later on, their commitment to the program. The total cost of feeds used in trials and covered by the program amounts to 21,000 SDP (1 US$ = 3 Sudanese pounds (SDP)). In addition, fuel costs used for the daily transport of students and of researchers (3 days/week) amounted to 2200 SDP. Other expenses incurred in the form of the driver's salary and financial inducements to labourers during the trials period amounted to 2500 SDP. Approximately 80% of the students' time and 40% of that of the researchers had been spent in these trials.

During the various meetings held with the selected operators, the responsibilities of the two parties were identified and agreed upon. The operators willingly allowed the free use of the available facilities on their feedlots such as balances, storage facilities for feeds, and feeding and drinking troughs. They also provided separate space for the selected animals and allowed the use of their labour to help in the conduct of the trials.

Researchers were allowed to select and isolate all the animals needed and to keep them for the whole period of the trial (about 70 days in each season). Operators also agreed to extend their currently used traditional concentrate feeds to the control animals. On-station tested feeds will be provided by the program for animals in the other treatments. Any losses caused by the trials as reflected in mortality or deteriorating condition of the experimental animals will be covered by the research supervisors.

At the end of each trial, it was also agreed that the researchers should be given priority in the purchase of a selected limited number of experimental animals for carcass evaluation. With the operators' deep involvement in the program and their highly cooperative spirit, no written agreement for these arrangements was made. The importance of concluding such an agreement to ensure the continuity of the program need not be emphasized. In our case, however, insistance on such an agreement may have offended the operators and affected the program. This verbal agreement is highly admired by the Sudanese but a written agreement may have been misunderstood by the operators and taken as an indication that their trustworthiness was in question.

Design of On-Farm Trials

The design of the feedlot trials was influenced by the variation between the systems, animals' responses, the seasonal price of ingredients, and the abundance of agricultural by-products. For these reasons, two similar trials were designed, one in each site. The same treatments carried out in the normal season will be repeated in the critical season. Two on-station-tested rations were used, one based on gassab (25% of the ration) and the other based on groundnut hulls (25% of the ration). These, in addition to a control treatment based on the conventional ration, were used by the operators. Accordingly, the following completely random design was formulated for each of the two sites: 2 (seasons) x 3 (treatments) x 10 (animals). The composition of the rations used in each treatment is given in Table 5.

Feeds Procurement and Processing

The quantities of feed required by the feedlot trials were calculated for a maximum period of 3 months. Procurement and processing of these feeds, carried solely by researchers, proved to be rather difficult because of the various channels through which agricultural by-products enter Khartoum and the less-developed marketing structures. Procured feeds were then transported to the single crushing mill available, packed in jute bags, and loaded to be stored in the selected feedlots.

Molasses was stored in cement ditches in the Faculty of Agriculture in quantities sufficient for 10 days, then regularly transported and stored in barrels at the selected sites. The anticipated wide use of agricultural by-products is expected to improve their delivery systems and stimulate the development of mills for their processing. Both costs of procurement and processing will, therefore, be appreciably reduced. In the selected feedlots, feeds are mixed daily under the supervision of researchers using the manually operated mixers specifically made for this purpose.

CONDUCT OF ON-FARM TRIALS

On-farm trials started immediately after animals reached the feedlots. Thirty animals were randomly selected, tagged, and weighed. They were then divided into three groups of approximately equal weight. Each group represents a separate treatment. However, because of the drought conditions and the sharp

Table 5. Composition of the rations used in the trials.

Ingredients	Dura straw-based ration (%)	Groundnut hull-based ration (%)	Control ration (traditional)
Crushed dura grain	15.00	15.00	Same as fed by the operators
Wheat bran	30.00	30.00	
Sorghum (gassab) stalks	24.75	-	
Groundnut hulls	-	24.75	
Alfalfa hay	7.50	7.50	
Molasses	20.00	20.00	
Urea	1.75	1.75	
Salt	1.00	1.00	
Total	100.00	100.00	

increase in the price of sorghum grain, the operator in the Mwielih area (traditional system) deviated from the normal 50% dura grain-based ration. Instead, he fed all his animals with cottonseed cake. For comparison purposes we provided him with dura grain at a subsidized price to have an additional control treatment.

The trials proceeded smoothly and according to plan without any loss of animals. Contacts between researchers and operators were maintained throughout the trials. In addition to their participation in the design and conduct of the research, they were, interestingly, making their own appraisal and evaluation of the trials. The results of the survey carried out at the end of the trials to examine the operators' responses to the use of agricultural by-product-based rations in finishing clearly demonstrated their satisfaction particularly with animal performance. The main reasons cited for their limited use of these materials relate to the seasonal availability of agricultural by-products and the lack of knowledge about ration formulation. Operators feel that both problems can be solved by the development of an agricultural by-products feed industry to which they can contribute.

ANALYSIS AND RESULTS

Finishing, as previously stated, represents one phase in the production process of beef cattle and is carried out by commercial firms. Hence, analytical frameworks, as used in commodity analysis or production of a specific enterprise, are particularly limited in explicitly incorporating parameters like rate of liveweight gain, time, interest and liquidity preference, value added, daily feed intake, variation in prices, and other complicated variables incorporated in the finishing phase. A suitable and flexible framework is, therefore, required to (a) compare the animals' responses and performance between treatments at the end of the trials (10 weeks), (b) compare profits and returns to finishing at the end of the trials, (c) determine optimum finishing periods for the different rations and compare profits and returns to finishing at that period, and (d) determine turnover within the season and compare seasonal profits from finishing beef cattle on different rations.

To achieve the objectives of the study, different analytical techniques were employed. The statistical analysis of variance was used to compare physical response and performance of the animals. Comparison of profits and returns to finishing can adequately be achieved by the construction of partial profit budgets. For the other two types of calculations, a combination of partial profit and cash-flow budget and marginality analysis were used. The effect of variation in prices was handled by sensitivity analysis within the constructed partial budgets.

Variations in feed intake, liveweight gain, and efficiency of feed conversion between the different treatments within the semimodernized system (Table 6) are not statistically significant ($P > 0.05$). However, animals fed on the dura straw ration by-products performed better than those fed on the conventional cottonseed cake ration and the combined cottonseed cake and sorghum grain ration.

It is also interesting to note the superiority of the dura straw ration compared to the groundnut hulls ration in both systems. Performance of animals in both systems was, more or less, similar, except for the relatively poor performance of animals fed on the groundnut hulls ration in the traditional system and the slightly lower feed intake of animals in this system, which could be attributed mainly to their relatively lower initial liveweight (Table 6). Based on these biological attributes, the results of the trials clearly demonstrated the possibility of substituting agricultural by-products for the conventional concentrate ration.

However, at the current high dura grain prices and low slaughter prices, the new control ration based wholly on cottonseed cake (CSC ration) excells the by-product rations in both systems (Table 7). Profits from finishing are positive only for this ration and the groundnut hulls ration in the semimodernized system because of both lower feed cost and high liveweight gain. Hence, the ratio of value added to capital invested in feed costs of finishing is greater than unity only for these rations. Interestingly, operators lost nearly 346 SDP/animal when the normal conventional ration (CSC + dura) was used. The low return to capital (0.39 SDP) clearly demonstrates the rational

Table 6. Beef cattle performance by ration and system of finishing during the normal season (August-February).

Parameters (kg/animal)	Traditional ration[a]				Semimodernized ration		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Feed intake per day	8.16	8.74	8.58	9.83	9.17	10.32	10.34
Initial body weight	283.40	283.60	283.60	284.30	340.50	340.00	340.50
Final body weight	355.70	362.50	329.90	369.90	424.00	427.00	416.50
Total body weight gain	72.30	78.70	46.30	85.60	83.50	87.00	76.00
Average daily liveweight gain	1.03	1.12	0.66	1.22	1.19	1.24	1.09
Feed efficiency (feed/gain)	7.92	7.80	13.00	8.06	7.71	8.32	9.49

[a] Rations: (1) control based on current conventional ration (cottonseed cake (CSC)), (2) dura straw-based ration, (3) groundnut hull-based ration, and (4) control based on normal nventional ration (CSC + dura grain).

Table 7. Profits from and returns to capital invested in beef cattle finishing per animal by system and type of ration after 10 weeks of finishing at current dura and meat prices (in Sudanese pounds (SDP)).[a]

Parameters	Traditional ration[b]				Semimodernized ration		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Slaughter value	527.86	537.95	489.57	548.93	618.09	633.67	629.22
Less cost before finishing	324.65	324.65	324.65	324.65	384.30	384.30	384.30
Value added due to finishing	203.21	213.30	164.92	224.28	233.79	249.37	244.92
Less finishing cost	200.97	223.97	180.96	570.78	221.23	274.60	237.09
Profit	2.24	-10.67	-16.04	-346.50	12.56	-25.23	7.83
Ratio of value added to finishing cost	1.01	0.95	0.91	0.39	1.06	0.91	1.03

[a] 1 US$ = 3 SDP.

[b] Rations: (1) control based on current conventional ration (cottonseed cake (CSC)), (2) dura straw-based ration, (3) groundnut hull-based ration, and (4) control based on normal conventional ration (CSC + dura grain).

behaviour of the operators in deviating from the use of this ration in the current season.

Drought and famine in the year under investigation have greatly affected meat and feed prices (particularly dura grain). Because of the feed shortage, most of the livestock owners increased their withdrawal with the resultant sharp decline in meat prices. Dura prices, on the other hand, increased by more than six-fold. To simulate the normal season, additional partial profit budgets were constructed under the following three situations: (a) current meat prices and projected dura price, (b) current dura prices and projected meat price, and (c) projected meat and dura prices.

Time series data were used to estimate trends employed in price projections. Results of the regression analysis of prices against time are given in Table 8. With the high multiple regression coefficients and highly significant F and T values, the projected meat and dura prices seem quite reasonable. Clearly, as shown in Table 9, both profitability and economic efficiency indicators are more sensitive to changes in dura prices than changes in meat prices.

With projected dura grain prices, the by-product rations are far superior to the current control concentrate ration (CSC ration). However, profits from the normal conventional ration (CSC + dura) are only realized if the normal pattern based on projected meat and dura prices is retained. Had increases in dura grain and meat prices followed the normal trend, the economic efficiency of the dura straw-based rations would have been 65 and 17% higher than that for the current conventional ration (CSC ration) in the traditional and semimodernized systems, respectively. The corresponding increase in the groundnut hulls ration is estimated at 93 and 67%, respectively. However, compared to the normal conventional ration (CSC + dura), the dura straw ration and groundnut hull ration are 98 and 114% more efficient, respectively.

Animals are traditionally finished for periods longer than the optimum. Results shown in Table 10 indicate that lower finishing periods are required by animals fed on the dura straw ration in both systems. Animals fed on the groundnut ration, especially in the

Table 8. Projected meat and dura prices in Sudanese pounds (SDP).[a]

Particulars	Meat (kg)	Dura (sack)		
		October	November	December
Intercept	-13.4554	-64.498	-63.3604	-64.4319
Regression coefficient (B)	+ 0.1808	+ 0.9967	+ 0.9692	+ 0.9692
T value	7.39	6.392	6.530	7.337
Level of significance (%)	0.01	0.01	0.01	0.01
F value	54.612	40.861	42.642	53.831
Level of significance (%)	0.01	0.01	0.01	0.01
Multiple regression coefficient (R^2)%	85	77	78	82
Coefficient of determination R%	92	88	88	90
Degrees of freedom	10	12	12	12
Average for last 3 years	1.371	16.66	15.66	14.67
Projected price for 1985	1.7326	18.65	17.61	16.61

[a] 1 US$ = 3 SDP.

Table 9. Returns to finishing at variable meat and dura prices per animal by system and type of ration after 10 weeks of finishing (in Sudanese pounds (SDP)).[a]

Parameters	Traditional ration[a]				Semimodernised ration		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
A. Value added at current meat prices	203.21	213.30	164.92	224.28	233.79	249.37	244.92
B. Value added at projected meat prices	291.64	303.42	246.93	316.24	337.33	355.52	350.32
C. Finishing costs at current dura prices	200.97	223.97	180.96	570.78	221.23	274.60	237.09
D. Finishing costs at projected dura prices	200.97	126.42	87.89	240.74	221.23	163.58	122.16
E. Profits at:							
1. Current meat price and projected dura price	2.24	86.88	77.03	-16.51	12.56	85.79	122.76
2. Current dura price and projected meat price	90.67	79.45	65.97	-254.54	116.10	80.92	113.23
3. Projected meat and dura price	90.67	177.00	150.94	72.45	116.10	191.95	228.21
F. Returns to capital at:							
1. Current meat price and projected dura price	1.01	1.69	1.88	0.93	1.05	1.52	2.00
2. Current dura price and projected meat price	1.45	1.35	1.36	0.55	1.52	1.29	1.49
3. Projected meat and dura price	1.45	2.40	2.81	1.31	1.52	2.17	2.88

[a] 1 US$ = 3 SDP.

[b] Rations: (1) control based on current conventional ration (cottonseed cake (CSC)), (2) dura straw ration, (3) groundnut hull ration, and (4) control based on normal conventional ration (CSC + dura grain).

Table 10. Returns and finishing per animal at optimum finishing period by system and type of ration at current meat and dura prices (in Sudanese pounds (SDP)).[a]

Parameters	Traditional ration[b]				Semimodernized ration		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Finishing period (weeks)	8.05	6.55	7.55	3.50	8.35	7.30	9.0
Liveweight of animal (kg)	342.85	345.16	324.19	317.85	406.8	414.45	418.0
Value of animal	508.78	512.22	481.10	471.69	603.7	615.04	620.31
Less: costs before finishing	324.65	324.65	324.65	324.65	384.30	384.30	384.30
value added (SDP)	184.13	187.57	156.45	147.45	219.4	230.7	236.0
Less: total cost of finishing (SDP)	160.31	150.15	131.42	186.79	184.9	199.2	214.37
profit (SDP)	23.82	37.42	25.03	-39.75	34.5	31.5	21.6
returns to finishing (SDP)	1.15	1.25	1.19	0.79	1.19	1.16	1.10
Length of normal season (weeks)	26	26	26	26	26	26	26
Turnover (number)	3.23	3.97	3.42	4.00	3.11	3.56	2.89
Seasonal profits (SDP)	76.93	148.51	86.19	-159.0	107.4	112.2	62.42

---

[a] 1 US$ = 3 SDP.

[b] Rations: (1) control based on current conventional ration (cottonseed cake (CSC)), (2) dura straw-based ration, (3) groundnut hull-based ration, and (4) control based on normal conventional ration (CSC + dura grain).

semimodernized system, take longer. Optimum finishing periods for the current control ration are, more or less, similar between the two systems. Losses from animals finished on the normal conventional ration (CSC + dura) are minimum at 3.5 weeks of finishing. Further feeding greatly increases losses from those animals. Marginal returns to finishing are, more or less, similar between treatments except for the normal conventional ration (CSC + dura). However, seasonal profits vary between treatments and between systems. In both systems, the dura straw ration generated the highest seasonal profit. Because of the longer optimum finishing period, seasonal profits reaped from the groundnut hull ration in the semimodernized system are lower than those obtained by feeding the current conventional ration (CSC ration) in both systems.

FEEDING CONSERVED FORAGES TO TRADITIONAL CATTLE IN THE NUBA MOUNTAINS, SUDAN

W. Trent Bunderson and Richard H. Cook

Western Sudan Agricultural Research Project/Kadugli
(WSARP), Agricultural Research Corporation, P.O. Box
5141, Khartoum South, Sudan

Abstract *In-herd trials allow for the testing of promising technologies under producer conditions, while simultaneously exposing the producers to the potential benefits derived from adopting the technology. Hay-feeding trials conducted by the Western Sudan Agricultural Research Project (WSARP) with sedentary and transhumant livestock producers have provided important insights into the procedures and problems of designing and implementing livestock in-herd experiments with different producer groups.*

Experiences of WSARP suggest that trials implemented with producers can be divided into two basic categories: (a) researcher-managed trials controlled by researchers but using the producer's animals or land, and (b) producer-managed trials, which may include recommended practices for management of the technology but with the implementation determined by the producer. The principal function of the former is to evaluate untested technology under the local conditions of the producer. This is particularly valuable for interventions representing substantial departures from traditional practices and concepts of management. Major advantages of trials in the researcher-managed mode are the low risk to producers, the early exposure of the target group to the new technology, and the ease of quantifying results through greater control over experimental conditions. Producer-managed trials should focus on pretested technologies, rather than on the introduction of unfamiliar technologies, the benefits of which are difficult for the producer to appreciate.

Résumé *Les essais faits sur les troupeaux permettent d'éprouver des technologies prometteuses dans leurs conditions d'emploi par les producteurs, et en même temps de présenter à ceux-ci les avantages qu'ils tireraient de l'adoption de telles technologies. Les essais d'alimentation au foin menés par le WSARP (Western Sudan Agricultural Research Project) avec les producteurs de bétail, que les troupeaux soient sédentaires ou transhumants, ont permis de mieux comprendre le processus et les problèmes touchant la conception et la mise en oeuvre d'expériences sur le bétail en collaboration avec différents groupes de producteurs.*

L'expérience du WSARP indique que les essais menés avec les producteurs peuvent se diviser en deux grandes catégories : (a) les essais menés par les chercheurs sur les animaux ou la terre des producteurs; (b) les essais menés par les producteurs, qui peuvent comporter des directives sur la façon d'appliquer les technologies, mais laissent l'initiative aux producteurs. La fonction principale du premier type d'essais est d'évaluer des technologies non encore éprouvées dans les conditions d'utilisation des producteurs. Ce genre d'essai prend toute sa valeur dans le cas de techniques s'écartant foncièrement des pratiques et des concepts traditionnels de gestion. Les principaux avantages des essais sous la direction des chercheurs sont : des risques moins élevés pour les producteurs, une prise de contact hâtive du groupe cible avec les nouvelles technologies, et la facilité de mesurer les résultats obtenus grâce à un plus grand contrôle sur les conditions d'expérimentation. Quant aux expériences menées par les producteurs, elles devraient porter sur des technologies déjà éprouvées plutôt que sur de nouvelles méthodes encore inconnues des producteurs et dont ceux-ci auront de la difficulté à évaluer les avantages.

THE NUBA MOUNTAIN REGION

The Nuba Mountain region is part of the overall target area of the Western Sudan Agricultural Research Project (WSARP), whose mandate is to improve the productivity and long-term stability of crop and livestock activities among traditional producers in Kordofan and

Darfur. Initial attention was focused on the Nuba Mountains for several reasons:

(a) The area contributes significantly to both crop and livestock production in western Sudan and is regarded by the regional and national governments as a priority area for agricultural development.

(b) The size and density of the rural population is one of the highest of any rainfed area in the country.

(c) The natural resources of the region are among the most productive in the west, and, with the comparative economic advantage of the indigenous farming groups, the area offers high potential for improving agricultural productivity and the integration of crops and livestock.

(d) The initiation of research was facilitated by considerable baseline information on specific aspects of the physical and agricultural environment and by an existing infrastructural component in the form of a functional research station.

A brief description of the research area and target groups of the Nuba Mountains follows (detailed descriptions of the major livestock systems in the area are contained in Bunderson et al. (1984)).

Human and Physical Resources

The research area occupies approximately 30,000 km^2 in the Nuba Mountain region of southern Kordofan and has a rural population exceeding 700,000[1] at a density substantially higher than any other area of comparable size in western Sudan. The area lies within the savanna zone of the Sudan-Sahelian belt and is classified as having a hot, semi-arid climate with a mean annual rainfall ranging from 600 mm in the north to over 800 mm in the south. Rain varies considerably in amount and distribution from year to year, but falls in a single season from June to October, leaving an extended dry season of 7 months.

---

[1] Calculated for 1985 from 1955/56 census information using trend line analysis at an estimated rural population growth rate of 1.8%/year.

Topographically, the region is characterized by flat or gently undulating plains of cracking and noncracking clays, interspersed with low hill ranges and their associated footslopes of coarser-textured sandy loams and clays. The hills and footslopes account for about 40% of the land surface with the plains occupying the remaining 60%.

Rangeland vegetation is closely related to soil type and topography and, although typically heterogeneous in structure and composition, can generally be classified as wooded savanna dominated by medium-tall annual grasses with varying proportions of deciduous and evergreen trees and shrubs.

Agricultural Activities and Target Groups

The research area of the Nuba Mountains is a major crop-producing region and supports a large population of resident and migratory livestock (Hunting Technical Services, Ltd 1981), including 350,000 cattle, 100,000 sheep, 300,000 goats, and an increasing number of camels currently estimated at double the 1975 figure of 35,000. Agricultural activities are dominated by two groups, a predominantly sedentary group of agropastoral tribes, collectively known as the Nuba, and the Baggara cattle-owning transhumants of Arab origin.

The Nuba account for 85% of the population, produce 90% of the crops, and own 35-40% of the livestock. Nuba groups are almost invariably located on or in close proximity to hill ranges, with their crop and livestock activities spanning the entire topoedaphic gradient from the shallow, sandy loams of the hilltops to the deep cracking-clay soils of the plains. Primary activities are centred on the hand cultivation of crops in a bush-fallow system that focuses on sorghum as the major field and food crop, with sesame, groundnuts, and cotton as the principal cash crops. Maize, cowpeas, and a number of vegetable crops are also grown for both subsistence and cash. Livestock production among the various Nuba tribes is based largely on a sedentary system of management dominated by cattle and goats, although sheep and pigs are raised to varying degrees depending on individual preferences and the influence of Islam. Patterns of resource use are characterized by relatively unrestricted grazing and high mobility, frequently involving a seasonal catenary sequence of movement between hilltops in the rainy season and the cracking-clay plains during the dry season.

In terms of priorities, Nuba farmers are concerned first with meeting their subsistence household needs for food on a year-round basis, a requirement largely dependent on cultivated crops. Surplus food and cash crops play an important role in achieving this objective, but these efforts are secondary to subsistence food production for the family. Livestock in the system function not only as a source of protein in a starch-dominated diet but also as a stabilizing influence and income-generating activity for diversifying risk and as a sound investment strategy to expand or improve agricultural production.

The Baggara transhumant tribes of the Hawazma and Meseriya represent about 10% of the population of the region but own 55-60% of the livestock and are among the most important producers of cattle, sheep, and goats in the province of Kordofan. The Baggara also extend well beyond the boundaries defined by the Nuba Mountain region and contribute significantly to domestic food consumption and foreign exchange earnings on a national basis. Production activities of the Baggara are animal-dominated with cultivation serving a limited, although important, function, primarily of subsistence. Cattle are the most important livestock raised, but considerable numbers of sheep and goats are also kept.

Market interactions function primarily for short-term cash needs rather than opportunities for investment or security in times of stress. The traditional strategy of investing an "apparent surplus of production" in the form of live animals is designed to off-set the fluctuation in herd size caused by high mortalities suffered during periods of severe drought or epidemic disease. Such strategies appear valid and well-justified, particularly under the current inflation rates of local currencies and material goods.

Livestock management involves a migration of varying distances to the more arid, sandier ranges in the north during the rainy season, returning to specific locations in the clay-dominated ranges of the south during the dry season. This traditional pattern of seasonal movement is essentially a well-adapted response to the availability of forage and water, changing environmental conditions, and the incidence of disease, parasites, and insect pests. Although migration routes frequently penetrate well into north Kordofan during the rainy season, more than 80% of the year is spent in the Nuba Mountain region where supplies of forage and water are more plentiful.

CRITERIA FOR DESIGNING AND IMPLEMENTING IN-HERD TRIALS

Preliminary investigative surveys of both the range and animal resources in the area clearly revealed that livestock production in the Nuba and Baggara systems was seriously affected by nutritional deficiencies during the dry season (Bunderson et al. 1984) and that diagnostic studies were necessary to identify the exact nature of the nutritional problem in terms of (a) the overriding or key nutritional factors involved, (b) the period(s) most limiting to the animal, (c) the class of animal most affected (age, sex, and physiological state), (d) the resulting impact on herd productivity, and (e) the cause-effect relationship of the problem.

Diagnostic surveys (see Bunderson et al. 1984) included evaluations of herd demographics and productivity; the current condition and productivity of rangelands in relation to grazing, fire, cultivation, and wood cutting; and the nutritional and health status of livestock by species and physiological age classes.

Based on data from these studies, cattle were regarded as the most important species to address because of their high numbers and economic value in the region and because they appeared to suffer the greatest nutritional stress. Of the alternatives available for alleviating nutritional constraints, supplementation using locally available products offered an attractive, short-term strategy for achieving a significant improvement in livestock production. Other options involving the improvement and development of communally used resources (e.g., grazing management systems, range and pasture improvement, fire control, etc.) were not considered viable under the current system of land use due to the inability of producers to implement the necessary level of management and control over the use of the resource base. The last 60 days of the dry season were identified as the critical period necessary for supplementation with protein, energy, and phosphorus representing the most limiting nutrients (Fig. 1). Attention was focused on the adult breeding female, particularly those in lactation and pregnancy, because these animals are under the greatest stress during the late dry season and providing maintenance levels of protein, energy, and phosphorus to these animals could result in substantial improvements in both conception rates and survivability of adult animals and their calves. The relationship between the dry season diet on offer and the requirements of cattle at different physiological states during the late dry season is shown in Fig. 1. Given the quality of the indigenous livestock, and the unstable, variable nature of the biological and economic environment, it was considered impractical to supplement at levels above basic maintenance.

Supplemental feeds were evaluated to determine those most practical and cost-beneficial. Evaluations included some sesame-seed cake, legume hay, sorghum stover, and harvested hay from native pastures. The advantages and disadvantages of these supplements are

Sesame-seed cake: This is an oil-seed concentrate high in crude protein (35-40%), energy, and phosphorus. The cake is produced locally, but supplies are limited because of the low number of presses in the area (all traditionally operated using camel power) and the fact that most sesame is produced for export out of the province. Prices per 50-kg sack are currently 40-50 SDP (1 US$ = 3 Sudanese pounds (SDP)) (Fadlalla, personal communication), excluding transportation, storage, and feeding costs. Thus, the use of sesame-seed cake appeared prohibitive because of its high cost and low availability.

Legume hay: Legumes generally provide a good source of protein (10-20% crude protein) and energy.

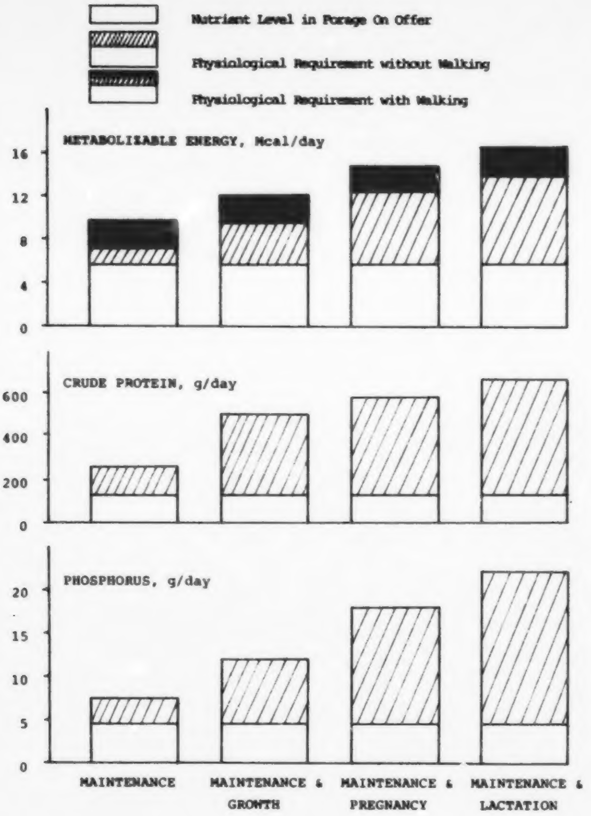


Fig. 1. Comparison of dry-season forage levels of metabolizable energy, crude protein, and phosphorus with physiological requirements. For "dry-season forage," nutrient levels were calculated using average values for the postflowering stage of grasses common to dry-season grazing areas. Total dry matter intake (DMI) was assumed to be 1.5% of body weight (Fadlalla 1984, unpublished). This value is consistent with a 20-25% reduction in food intake calculated from the decreased time available for grazing in the dry season (see text). For "phosphorus with physiological requirements," nutrient requirements were calculated for a 250 kg cow, growth = 0.25 kg/day and milk production = 4.0 kg/day, from Kearls (1980). For "physiological requirement without and with walking," energy expenditures for walking were calculated at 0.5 cal kg^{-1} m^{-1} (Kearls 1980).

However, the proportion of legumes in both the native vegetation and under cultivation is low. Cultivated legumes are limited to groundnuts as sole crops and cowpeas as intercrops with sorghum and sesame. In the initial evaluation, legume hay was precluded from in-herd feeding trials because of its limited abundance and the need for a relatively intensive, long-term research effort to establish and promote methods for increasing the abundance of legumes in both the native vegetation and the existing cropping system.

Sorghum crop residues: Following the December and January harvest, sorghum residues are abundant but inefficiently used as livestock feed. The major constraint to their efficient use is the shortage of labour and the time necessary to secure conservation of the residue before being consumed by livestock in the field. This is related to the problem that, once harvested, a field is open for communal use of the crop residues. In terms of quality, sorghum stalks provide about 3.8-5.5% crude protein, which was not considered high enough to justify its use as a feed supplement, despite its abundance and low cost.

Native hay: For rangelands in the Nuba Mountains, about 6% of the annual primary production, compared to more than 25% in other parts of Africa (Bunderson 1984) is utilized by grazing livestock. This is particularly true of the cracking clays that are used by both sedentary and migratory livestock during the dry season when the available forage has declined sharply in both quantity and nutritional value. Given the abundant and relatively high-quality forage on these soils during the growing season, efforts to conserve hay at this time appeared to have several advantages over alternative supplements.

Design and Implementation of Hay-Production Activities

The harvesting and storage of native hay was undertaken with station resources for two basic reasons. The scientists were unsure of the outcome, and it was unlikely that local farmers would allocate scarce resources for a new activity with unknown benefits.

Efforts at harvesting and storing hay were designed to simulate as closely as possible the potential methods and resources available to the producer. Harvesting was accomplished using locally hired labour, at 1.25 SDP/day, and hand-tools used traditionally in collecting grass for thatching during the dry season. Ideally, the operation depended on securing hay at a stage of growth that would supply an adequate level of nutrition without excessive risk of exposure to rain. Given the early maturing nature of most plants in the area, harvesting should take place during the first 2 weeks of September just before flowering and some 40 days before the end of the rains.

Our initial effort at harvesting hay in 1982 failed because of spoilage caused by almost twice the amount and frequency of rainfall normal for September. A second attempt was undertaken in late September/early October in the same season, but the timing substantially reduced the quality of hay originally expected. Transport of the hay was carried out with a 6-t truck because of the distance between the harvested site and the research station. A total of about 7 t of hay were stored in loose 10-kg bundles placed on a platform of locally constructed material with sides 3 m high. The entire hay operation from start to finish required approximately 50 man-days over a period of 2 weeks (i.e., 140 kg/man-day).

In the 1983 season, we expected to produce better-quality hay, but problems were encountered similar to those of the previous year. In addition, a lower quantity of hay was harvested, while ox-drawn carts[2] were used for hay transport.

Design and Implementation of On-Farm Feeding Trials

On-farm feeding trials were considered to offer greater advantages over on-station experiments by demonstrating any potential pay-off to the producer and shortening the period necessary for the transfer of technology. Such trials also provide a more relevant context in which to evaluate hay-feeding to traditional cattle, and with the experience and improved understanding gained from the interaction, modifications can then be designed to make the technology more compatible with the objectives and priorities of the producer.

---

[2] Animal draft is under test by WSARP and the Nuba Mountain Rural Development Project as a potential labour-saving intervention for improving the timing and efficiency of crop-related activities with traditional producers.

Feeding trials using native hay consisted of producer- and researcher-managed experiments in 1983 and 1984, respectively. The producer-managed trials involved two separate groups; five Baggara transhumants from the same cattle camp, and two Nuba farmers from a specific village. The researcher-managed experiment involved only one Nuba farmer but was designed to clarify the inconclusive results obtained from the previous season's producer-managed trials. Details of these experiments follow.

Producer-Managed Trials in 1983 Producers selected for participation in the feeding trials were invariably individuals who had developed a long-term association with project staff during the course of exploratory and diagnostic surveys. The advantage of choosing these producers was that they were familiar with the objectives of the project and the type of research being conducted. They also appreciated that these efforts were aimed at improving their agricultural production and overall livelihood. Because of these factors, cooperation was greatly facilitated in conducting experiments that involved the handling of animals.

Additional motivation was provided by simply supplying the hay free of cost. The design of the trial involved a 60-day period of hay supplementation, from 1 April to 1 June, to nonpregnant, nonlactating female adults. Although we originally planned to use lactating females, a complication was caused among the Baggara who sometimes supplement a portion of their milking animals with sesame-seed cake, when this is available. (The practice is usually limited to Baggara groups located adjacent to urban centres where there is a high demand for milk and where sesame cake is more likely to be available.) The purpose of this practice is to improve household income through increased milk sales to urban populations during the dry season when the supply of fresh milk is low. We, therefore, opted for nonlactating, nonpregnant females to avoid disrupting this practice and any problems that could obscure the results of the hay-feeding experiment. Within the physiological age class specified, the selection of animals was left to the producer. For the Baggara, a total of 20 cattle were supplemented, but divided into groups of four animals from each of five producers, with an equal number of control animals of similar age and physiological state. The same procedure was carried out with the two Nuba farmers, except that only six animals were supplemented, four from one producer and two from the other. It was also hoped that the use of nonpregnant, nonlactating females would help reduce experimental errors associated with the small sample size.

Recommendations were made to each producer to feed approximately 10 kg of hay to each group of four animals on a daily basis (determined at half the dry matter intake from grazing for a 200-kg animal). Normal grazing, watering, and herding patterns were to be followed with no separation of the supplemented or control animals from the rest of the herd during these activities. The only introduced change was the feeding of hay in the evening following the usual afternoon grazing period. The feeding of hay was the responsibility of the producer household, and this was facilitated by erecting a small thorn-bush enclosure to separate the supplemented animals from the rest of the herd, as well as from other species of livestock, during the feeding period. Hay used by producers was transported by station staff in sufficient quantities to feed animals for a period of 10 days. Storage of these 10-day supplies was accomplished by placing the hay on the roof of a simple wood and straw structure used traditionally by most transhumant households.

The major parameter of interest was a comparison of weight change between supplemented and control groups during the supplement period. Animal weights were recorded at the start and end of the experiment using a 500-kg capacity, portable livestock scale that could be loaded onto the back of a large truck or pulled on wheels behind a smaller vehicle. For each of the two locations, a corral and crush made from local vegetation was constructed to facilitate the weighing process. These enclosures were only temporary and could be built for about 35 SDP in 1 day.

A number of other observations were recorded during the course of the experiment, including animal illnesses, mortalities, and the general pattern of feeding as managed by individual producers. Most of these observations were qualitative in nature and were conducted by one technician, occasionally accompanied by a senior scientist, during an average of 6-8 visits/month for each location. No attempt was made to measure the actual quantities of hay offered and consumed by animals on a daily basis for each producer group, although a general assessment of these factors was made visually during visits.

Apart from the livestock scale mentioned earlier, the resource most heavily used was a ¾-ton four-wheel-drive truck. This type of vehicle was necessary because of the rough terrain and poor roads in the area and also for transporting the hay at 10-day intervals to the producers at each location. The vehicle was required for all visits to the Nuba community, which involved a round-trip distance of about 25 km and travel time of 1.5 hours. Trips to the Baggara group were much closer (about 1 km away) because they were settled for the dry season near a traditional watering point located adjacent to the research station. Visits to this group for recording observations were usually made on foot.

Methods for evaluation involved standard statistical procedures for assessing weight differences between control and supplemented animals in each group. Economic analyses were based on the quantitative costs of harvesting, transporting, storing, and feeding the hay in relation to the more qualitative, biological benefits gained through improved survival and reduced weight loss. Producer perceptions of the results were based on informal interviews, focusing on the producer's evaluation of his ability and willingness to undertake the intervention using his own resources.

Researcher-Managed Trial of 1984 This trial was designed to achieve a higher level of control over the feeding of hay to establish better the costs and potential value of the forage to lactating animals during the dry season. The trial differed from the producer-managed experiments in several ways:

(a) The feeding operation was managed by researchers to maximize the biological potential of the intervention and to measure accurately the daily intake of hay on offer;

(b) A change in grazing practices for the supplemented animals was introduced by replacing the afternoon grazing period with the feeding of hay, the principle being to reduce the probable energy deficit associated with the afternoon search and intake of poor-quality forage, the availability of which was severely limited;

(c) Lactating animals were selected for supplementation, because any other class would be likely to produce a clear benefit in terms of increased productivity;

(d) For reasons discussed later, the Baggara were regarded as an inappropriate group for the intervention and were, therefore, excluded from the trial;

(e) Only one producer was involved, namely a Nuba with a relatively large herd, which could reduce experimental errors and logistical problems caused by using animals from numerous producers;

(f) Two research assistants were stationed, full-time, in the field to manage the feeding operation and to record the daily quantities of hay provided to (ad libitum) and ingested by supplemented animals; they also reported any irregularities or problems, such as animal mortalities, occurring during the feeding period; and

(g) Gastrointestinal and hemoparasitic status of supplemented and control animals was assessed at the start and end of the experiment to determine possible complications caused by these factors; resource requirements of this aspect of the trial included a centrifuge, mobile refrigerator, and microscope, and approximately 10 man-days of field and laboratory work.

RESULTS AND DISCUSSION

Trials with Nuba Cattle (1983/84)

Chemical analysis of the hay fed for both years showed a crude protein content of only 4.2-4.5%. This was considerably below the expected crude protein level of 6-8%. The basic constraints faced in producing high-quality hay were the time and labour required to harvest early maturing pastures at a peak stage of nutritive content, without the risk and damage of rain during the last month of the wet season.

Changes in cattle weights for the producer-managed experiment of 1983 are shown in Table 1. The supplemented group lost significantly less weight (33%) than the control, but the difference was not sufficiently dramatic for the producers or researchers to see a clear production benefit. (This is mainly due to the fact that nonproductive animals were fed hay.) Although this was influenced by the hay quality fed (see Fig. 2), the design of the experiment made it difficult to assess the actual contribution of the hay to the noted group differences.

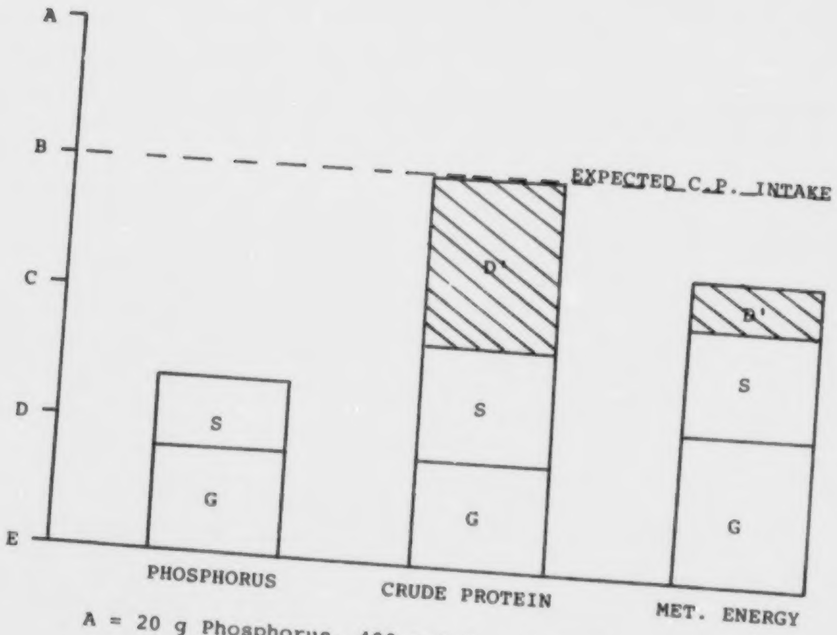
In the 1984 researcher-managed trial, weight changes between the supplemented and control groups over the 60-day period of feeding are presented in Table 2. The results show no difference in weight loss between the groups at the 99% confidence level, demonstrating no advantage of feeding hay to lactating female cattle during the late dry season. This is supported by data on the dry matter consumption of hay by supplemented animals (see Table 3), which show that the average hay intake of 2.5 kg/animal per day, at a crude protein content of 4.5%, would supply only 25-30% of the total protein required by lactating cows producing 1 kg of milk per day. By adding this quantity to that calculated for grazing, lactating animals would show a protein deficit of 45-50% for the last 2 months of the dry season (see Fig. 3).

Total labour costs associated with the production and feeding of hay over the 60-day period were 1.86

Table 1. **Weight changes in control and hay-supplemented groups of Nuba cattle over the period 1 April to 1 June 1983 (nonlactating and nonpregnant females).**

Animal number	Supplemented group			Control group		
	1 April weight (kg)	1 June weight (kg)	Percentage change	1 April weight (kg)	1 June weight (kg)	Percentage change
1	200	175	-12.50	207	181	-12.56
2	273	235	-13.92	240	189	-21.25
3	191	177	-6.84	211	171	-18.96
4	248	214	-13.71	227	183	-19.38
5	141	124	-12.06	154	132	-14.29
6	184	168	-8.70	174	149	-14.37
Total	1237	1093	-	1213	1005	-
Mean	206	182	-11.28[a]	202	167	-16.80[a]
Range	141-273	124-235	6.84-13.92	154-240	132-189	12.56-21.25

[a] Mean weight changes for the control and supplemented groups are significantly different at the 0.05 probability level.



A = 20 g Phosphorus, 400 g C.P., 16 Mcal of M.E.
B = 15 g Phosphorus, 300 g C.P., 12 Mcal of M.E.
C = 10 g Phosphorus, 200 g C.P., 8 Mcal of M.E.
D = 5 g Phosphorus, 100 g C.P., 4 Mcal of M.E.
E = 0 g Phosphorus, 0 g C.P., 0 Mcal of M.E.
S = Supplied from Supplement
G = Supplied from Grazing
D'= Quantity Deficient

Fig. 2. A 1983 hay-feeding trial with nonlactating/nonpregnant cows.

SDP/animal with a capital cost[3] of 2.81 SDP including the use of oxen-drawn carts. The overall conclusion was that because of the conflicts in labour demands

---

[3] Capital cost including transport costs using a cart and pair of oxen. Of these, 80% were recurrent costs for spare parts and supplemental feed for the oxen during the dry season and 20% for annual payment for the cart.

Table 2. Weight changes in control and hay-supplemented groups of lactating Nuba cattle from 15 April to 15 June 1984.

	Supplemented group			Control group		
Animal number	15 April weight (kg)	15 June weight (kg)	Percentage change	15 April weight (kg)	15 June weight (kg)	Percentage change
1	256	210	-17.97	234	200	-14.53
2	250	224	-10.40	260	227	-12.69
3	207	171	-17.39	263	234	-11.03
4	246	211	-14.23	182	Died	-
5	242	203	-16.12	238	206	-13.45
6	246	221	-10.16	283	254	-10.25
7	201	164	-18.41	216	179	-17.13
8	230	196	-14.78	209	186	-11.00
9	214	180	-15.89	232	193	-16.81
Total	2092	1780	-	2117	1679	-
Mean[a]	232	198	-15.04[b]	235	210	-13.36[b]
Range	201-256	164-224	10.16-18.41	182-283	179-254	10.25-17.13

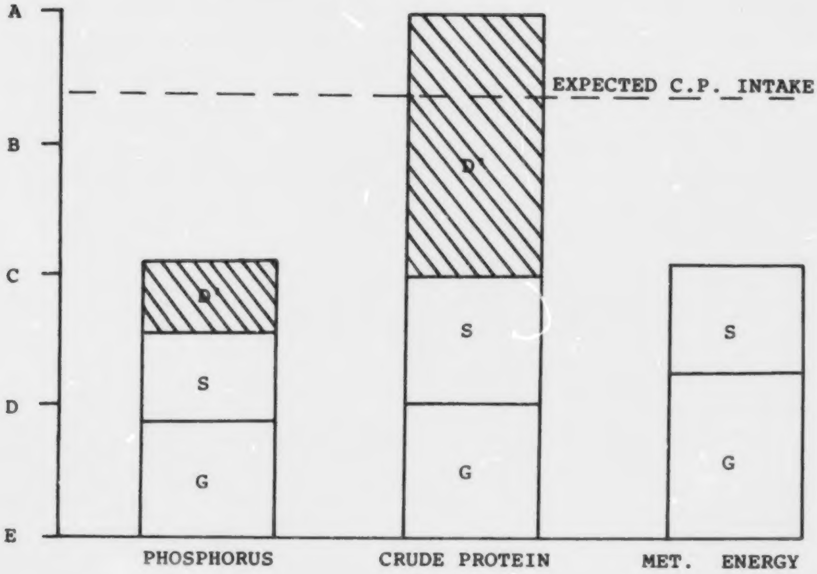
[a] Mean weights and changes for the control exclude the death of animal no. 4.

[b] Mean weight changes for the control and supplemented groups are not significantly different at the 0.01 probability level.

Table 3. Relationship between mean daily quantities of hay offered, refused, and ingested by the supplemented group of cattle over 10-day intervals during the period of feeding, 1984.

Period	Mean weight of group[a] (kg)	Quantity of hay offered (kg)	Quantity of hay refused (kg)	Quantity of hay ingested (kg)	Mean quantity ingested/animal (kg)	Hay ingested as % body weight
16-25 April	230	37.8	10.7	27.1	3.01	1.31
26 April - 5 May	226	32.0	7.0	25.0	2.78	1.23
6-15 May	221	26.1	5.0	21.1	2.34	1.06
16-25 May	215	26.2	4.7	21.5	2.39	1.11
26 May - 4 June	208	23.2	4.6	18.6	2.07	1.00
5-14 June	201	21.6	3.8	17.8	1.98	0.99

[a] Mean weights for the group in consecutive 10-day intervals was calculated by assuming that 40% of the total weight lost by the group over the period of supplementation occurred during the first 30 days with 60% during the last 30 days.



A = 20 g Phosphorus, 400 g C.P., 16 Mcal of M.E.

B = 15 g Phosphorus, 300 g C.P., 12 Mcal of M.E.

C = 10 g Phosphorus, 200 g C.P., 8 Mcal of M.E.

D = 5 g Phosphorus, 100 g C.P., 4 Mcal of M.E.

E = 0 g Phosphorus, 0 g C.P., 0 Mcal of M.E.

S = Supplied by Supplement

G = Supplied by Grazing

D'= Quantity Deficient

Fig. 3. A 1984 hay-feeding trial with lactating cows.

between hay and cropping activities and the physical restrictions on producing hay of sufficient crude protein content, alternative supplements needed to be examined.

Trials with Baggara Cattle (1983)

The results of the producer-managed trials with Baggara transhumants were virtually impossible to evaluate on a quantitative basis because of the influence of the human element in how the experiment was managed. In contrast to the sedentary producer, the hay provided to each transhumant was frequently fed to animals that were not part of the experiment, mainly donkeys and sick animals. Although this reflected their perception of how best to utilize the hay, and what animals to feed it to, the effect interfered with the design of the experiment to the point where variations in feeding could not be quantified. An additional problem was encountered during the scheduled weighing at the end of the experiment when a portion of the herds, chiefly nonlactating animals, had started their trek northward with the young men of the household in response to the early rains. This fact coupled with four deaths in the control group, and one death in the supplemented group, made a proper statistical evaluation impossible. The mortalities themselves had questionable significance on the effect of feeding hay because the cause(s) of death were unknown. Because the migratory patterns of Baggara households do not facilitate convenient control over the critical period of hay harvesting during the rainy season, the heavy physical labour involved is unfamiliar to most transhumants, and the larger size of their herds requires the harvesting and storage of considerable quantities of hay, the Baggara were considered ill-suited for the intervention.

Future Recommendations

Based on experiences gained, WSARP is currently using researcher-managed trials to address more appropriately the nutritional constraints of livestock in the Nuba Mountains. Preliminary estimates of the limiting nutrients, critical period of supplementation, and class of animal to feed, still appear valid (see Fig. 1). In terms of quality, the bottom line for an adequate supplement is 6-8% crude protein, which for native hay would require mechanization beyond the capabilities of traditional producers. Several alternative supplements are under examination for meeting most, if not all, of the criteria specified above.

Sorghum stalks represent an abundant, readily accessible crop residue, the use of which would pose minimal conflict with other cropping activities. Recent studies on feeding behaviour in the dry season indicate a preference by cattle for sorghum residues over the natural vegetation. However, the protein content of the residue is not adequate to provide even maintenance levels if fed alone. Because the potential exists for expanding legume production among traditional groups, combinations of legume hay/sorghum stalks could provide supplements containing 8-10% crude protein, thus supplying 60-80% of the total crude protein requirements for lactating cattle; a significant proportion of the metabolizable energy would also be supplied, the balance likely being obtained through normal grazing. The total benefit from the legume portion would come from its contribution to dietary protein, which improves both intake and digestibility to the grazing diet.

The major constraint to the introduction of forage and grain legumes on a larger scale than presently exists in the region is that the legume crop may compete directly for land and labour resources currently used by the producer for his traditional cropping activities. This problem, together with the time, cost, and effort necessary to conserve both legume hay and sorghum residues, represents the major obstacle being addressed through adaptive research trials. These trials are examining (a) dual-purpose legumes for grain and forage, which are intercropped with sorghum and sesame, rather than cultivated as sole crops; (b) livestock supplementation with legumes and combinations of sorghum stover and legume hay to meet crude protein maintenance requirements for lactating or pregnant animals; (c) reducing the conflict in labour allocation between the production of food/cash crops and forage; and (d) improvements in the construction and life expectancy of ox-drawn carts to integrate better crop and livestock activities through a more cost- and labour-efficient harvest of crops and crop by-products.

REFERENCES

Bunderson, W.T. 1984. Primary productivity and energetic relationships of wild and domestic ungulate communities in African ecosystems.

Proceedings of the 2nd International Rangelands Congress, Adelaide, Australia, 13-19 May, 1984.

Bunderson, W.T., Fadlalla, B., and Cook, R.H. 1984. Range/livestock research activities for 1982/83. Khartoum, Sudan, Western Sudan Agricultural Research Project (WSARP), publication number 29.

Hunting Technical Services Limited 1981. South Kordofan central districts rural development plan. Borehamwood, U.K., Hunting Technical Services Limited.

1974. Southern Darfur land-use planning survey. Annex 3: animal resources and range ecology. Borehamwood, U.K., Hunting Technical Services Limited.

Kearls, L.C. 1980. Nutrient requirements of ruminant livestock in developing countries. Logan, Utah, USA, Utah State University Press, p. 123.

DEVELOPMENTAL APPROACH TO ON-FARM RESEARCH: PILOT PROJECT FOR IMPROVING SMALL RUMINANT PRODUCTION IN HUMID WEST AFRICA

Akwesi Atta-Krah

Small Ruminant Programme, International Livestock
Centre for Africa (ILCA), PMB 5320, Ibadan, Nigeria

Abstract *On-farm research forms an integral part of the research strategy of the International Livestock Centre for Africa's (ILCA's) Small Ruminant Programme. It provides information and ideas to assess and enhance the relevance of proposed interventions, such as alley farming, to the small ruminant production system. Alley farming intervention seeks to improve small ruminant production by linking it with arable crop production through the use of fast-growing leguminous trees for fodder and mulch.*

The development of the program's on-farm alley farming research is analyzed from the first on-farm planting in 1980 through to the initiation of a government-sponsored pilot alley farming project in 1984. The pilot project, which is the focus of this paper, is being carried out on 68 farmers' farms and with farmers' animals. ILCA's involvement is limited to supplying browse seed, planting and management suggestions, and vaccination against Peste des Petits Ruminants (PPR), a major disease in small ruminants in the tropics. Its main role is to monitor and evaluate alley farming under different kinds of farmer management in a range of environments.

The methodology adopted for this kind of research is discussed and the significant problems and opportunities created are outlined. Initial results indicate that given the right approach, and a farmer-relevant proposal, farmers are willing, even without credit, to experiment with new ideas. Suggestions are made concerning the nature and analysis of the data derived from the project.

Résumé *La recherche sur le terrain fait intégralement partie de la stratégie de recherche du Programme sur les petits ruminants du CIEA (Centre international de l'élevage pour l'Afrique). Elle fournit des renseignements et des idées pour évaluer et améliorer le bien-fondé des propositions d'interventions qui, comme la culture intercalaire, visent le système de production des petits ruminants. Ainsi, la culture intercalaire a pour but d'améliorer la production des petits ruminants en liant celle-ci à la production agricole grâce à l'emploi de légumineuses arbustives à croissance rapide comme fourrage et paillis.*

L'élaboration du programme de recherche sur la culture intercalaire est ici analysée à partir de la première plantation agricole, en 1980, jusqu'au lancement, en 1984, d'un projet pilote de culture intercalaire parrainé par le gouvernement. Ce projet pilote, qui est le sujet de cette communication, se déroule dans 68 exploitations appartenant à des agriculteurs et porte sur les animaux de ces exploitations. L'apport du CIEA se limite à l'approvisionnement en semences pour les pâturages, à des conseils pour l'alimentation et la gestion, et à la vaccination des bêtes contre la "peste des petits ruminants (PPR)," maladie commune chez les petits ruminants des zones tropicales. La fonction principale du CIEA se résume donc à suivre et à évaluer les cultures intercalaires des diverses façons qu'elles sont pratiquées dans des environnements également divers.

On discute, au cours de la communication, de la méthodologie adoptée pour ce type de recherche; on relève les problèmes importants et les ouvertures nouvelles. Les premiers résultats indiquent que, si la bonne approche est adoptée et s'appuie sur des propositions intéressantes pour l'agriculteur, ce dernier accepte volontiers, même sans crédit, de faire l'essai de nouvelles techniques. Les notes finales concernent la nature et l'analyse des données fournies par le projet.

On-farm research (OFR) forms an integral part of the overall research strategy of the International Livestock Centre for Africa's (ILCA's) Humid Zone Programme based in Ibadan, Nigeria, and is used to gain information and ideas particularly related to the relevance of proposed changes in the small ruminant production system. Two main types of on-farm

research are carried out by ILCA. The first is trials for the evaluation of various veterinary treatments, and the second is agronomy trials based on a fodder intervention (alley farming). The veterinary trials are designed and executed very much like traditional research-station trials, with treatments, replications, randomizations, and so forth; the data can be statistically analyzed. Such trials require a high degree of control by the researcher, even though farmers are automatically involved in that their animals are being used.

The on-farm agronomy trials, on the other hand, are without specified treatments and replications and aim at the assessment of the relevance, workability, and acceptability of proposed interventions (usually developed in station research) to farmers. Such trials are essentially flexible and allow the further development of the proposed systems by farmers under different management and environmental conditions. These "trials" employ extension procedures, rather than those of traditional research, to maximize farmers' involvement and achieve total farmer control and responsibility.

ILCA's on-farm agronomy work is based on alley farming, which is the cultivation of crops between rows of fast-growing leguminous trees that are managed to provide nitrogen-rich mulch for crops and high-protein fodder for small ruminants. Alley farming was developed from the alley cropping concept originated by the International Institute of Tropical Agriculture (IITA) (Kang et al. 1981) and links crop and animal production, aiming at sustained crop productivity as well as improved small ruminant production (Sumberg 1984). Alley cropping is considered an improvement on the traditional bush-fallow system in that it has potential for checking degradation of the soil and rapid declines in soil fertility and crop yields (Wilson and Kang 1980).

On the basis of the existence at IITA of a comprehensive body of knowledge from on-station research on alley cropping, not much basic research work was embarked upon by ILCA before the commencement of OFR activities. ILCA's major concern was how the alley cropping idea could fit into the traditional farming system for the integration and improvement of crop and livestock production and what modifications would be needed to make it more practicable and relevant under farmer conditions. It was also ILCA's concern to identify new and relevant areas of research that require further study in on-station trials.

ILCA's on-farm alley farming research began in 1981 on a farm at Laperi, near Ibadan. By June 1983, a total of 16 farmers had established and were managing alley farms with varying degrees of commitment and success (Atta-Krah 1983). The model itself has gone through numerous modifications and its focus has changed considerably from a specialized animal feed production strategy to an overall improvement of the farming system. The level of farmer participation, control and responsibility has increased gradually during the period, whereas that of the researcher has declined. The results achieved and the experience gained from these on-farm activities have culminated in a government-sponsored pilot project aimed at improving small ruminant production systems in southwest Nigeria.

This paper describes the approach and methodologies adopted for this combined research and development project. It illustrates the need for closer links between research and extension in the development and evaluation of a technology before its incorporation in a national development plan.

PILOT PROJECT

The project was initiated in November 1983, by the Livestock Project Unit (LPU), a World Bank-sponsored arm of the Nigerian Federal Livestock Department. It is based largely on ILCA's alley farming model, which has two components: (a) the establishment of a 0.3-ha alley farm with Leucaena leucocephala and Gliricidia sepium (farmer responsibility), and (b) annual vaccination against Peste des Petits Ruminants (PPR), a viral disease causing major mortalities in small ruminants (carried out by ILCA).

ILCA monitors and evaluates the project in addition to having technical responsibility for it. Designed to involve about 60 farmers in year one, the project presents a unique opportunity for ILCA to monitor alley farming under different kinds of management in a range of environments. It also represents a logical extension of ILCA's research program in that it focuses on improving existing production systems rather than attempting to substitute new ones.

The project was originally conceived by the LPU as a pilot loan program for small-scale sheep and goat producers. The loan, 400.00 Naira (1 Naira (NGN) = US $1.30) per farmer, extending over 2 years, was meant to cover costs of establishing the alley farms, veterinary care, and constructing housing for farmers' small ruminants. It was to be administered, on behalf of the LPU, by the State Department of Cooperatives. The Department was also expected to help identify a site and farmers and to be responsible for the repayment of the loans. Following ILCA's expression of concern over involving farmers unnecessarily with credit, the loan component was dropped, and the involvement of the Department of Cooperatives ended.

APPROACH AND METHODOLOGIES

An activity schedule covering the first 2 years of the project is shown in Table 1. This schedule was needed to give direction to the project and to assess the progress made over time. The different kinds of activities to date are described in the following.

Tree Seed Production

Between December 1983 and March 1984, ILCA put considerable effort into collecting and processing seed of Leucaena and Gliricidia. Leucaena seed was collected from improved materials (mainly K8 and K28 cvs) planted within the compound of IITA in Ibadan, but Gliricidia was collected from unimproved local materials growing in and around Ibadan and Oyo towns in southwest Nigeria. Approximately 70 kg of Gliricidia and 45 kg of Leucaena were collected and processed during the period.

Site Selection

This exercise was crucial, because an inappropriate choice could easily have led to the collapse of the project. The selection involved extensive traveling and

Table 1. Integrated alley farming model activity schedule.

Time	Activity
1983	
Oct	Site selection and village contacts (ILCA)
Nov-Dec	Potential participating farmers enlist
1984 Jan	Collection and processing of browse seed begins (ILCA) Vaccination of sheep/goats with TCRV (tissue-culture rinderpest vaccine) (ILCA - vaccine supplied by LPU)
Jan-Mar	Land preparation (farmer)
Feb-Mar	Train technical staff (including LPU extension officer) (ILCA)
Apr-May	Plant fodder trees plus first-season crop (farmer)
May	Follow-up vaccination - TCRV (ILCA) LPU extension technician takes residence in pilot village Periodic farm evaluation begins (LPU/ILCA)
Aug	Harvest first-season crop (farmer)
Sept	Plant second crop (farmer)
Dec	Harvest second crop (farmer)
1985	
Jan-Dec	Project evaluation (LPU/ILCA)
Apr-May	Prune trees for mulch and feed, plant first-season crop in alleys
May-Jul	Maintain farm, prune trees as needed, develop routine browse use program (farmer)
1986	
Aug-Jan	Continue cropping, prune trees for mulch and feed

aerial surveys within two local government areas of Oyo State, Nigeria.

Oyo State was selected out of the 10 states in the humid zone of Nigeria simply on the basis of proximity. The intensive monitoring required for on-farm research makes proximity an important consideration in site selection. The criteria for selecting pilot villages were (a) evidence of active arable farming, and (b) evidence of interest in small ruminant husbandry. The first criterion was measured on the basis of numbers, distribution, and quality (level of management) of farms in the area, whereas the second was determined simply on the population and distribution of sheep and goats in the community. Two villages in the Ejigbo Local Government Area, Owu-Ile and Iwo-Ate, appeared to satisfy these criteria and were selected as pilot villages. Both lie in the transition zone between forest and savanna; there are, therefore, both forest- and savanna-type farms in the region.

Preliminary Village Contacts

Following the identification of the villages, the village chiefs were contacted and village meetings organized to present and discuss the proposed project. Two meetings were held in each village between October and November for this purpose. These initial contacts are critical in any on-farm research program and must be orchestrated to capture the interest of the farmers. Brightly coloured posters, depicting various stages in the establishment of an alley farm, were distributed to farmers at these first meetings. In addition, samples of browse trees and browse seeds were displayed. It is essential that critical issues such as funding, credit, and the respective commitments and responsibilities of the parties involved are outlined to avoid misunderstandings and misconceptions at these initial stages.

Introductory Field Tours

A farmer's perception and understanding of a proposed innovation is greatly enhanced if the innovation can be seen in practice under conditions similar to the farmer's own. The use of research-station trials for this purpose can be counterproductive, as the farmer may be distracted by the many ongoing trials on the station, and is also likely to see the research station as unreal and foreign. To this end, visits were organized for them to some of the early farmers' alley farms in the Fasola and Ikire areas. Fasola is a village 30 km west, whereas Ikire is about 80 km southeast of the project site. Farmers in the two pilot villages were taken on two separate days to visit the old farms at the Fasola and Ikire areas. This gave them an opportunity not only to get a better idea of what alley farming involved but also to interact and exchange ideas with active alley farmers. They also saw the farmers' sheep and goats feeding on Leucaena and Gliricidia leaves. After these visits, 45 farmers in Owu-Ile and 33 in Iwo-Ate registered to participate in the project. The only condition of participation was the farmers' conviction in the potential of the system and their willingness to give it a try. The issue of compensation was considered irrelevant and no incentives were given or promised. ILCA, however, agreed to provide the tree seeds and LPU would supply the tissue-culture rinderpest vaccines (TCRV) - both at no cost to the farmer. The estimated costs for the seeds and vaccines required per farmer were 1.50 NGN and 4.50 NGN (for 3-4 animals), respectively.

Baseline Farm Survey

To assess the suitability of various farms intended for the project, the farms were inspected between November and December of 1983. A total of 74 farms, 43 in Owu-Ile and 31 in Iwo-Ate (Table 2), were inspected and registered for the project. Five farms were rejected on the basis of evidence of poor farm management or intense shading from tree crops, such as orange, kola, and cocoa. An observation sheet and a short questionnaire were filled out for each farm to provide some baseline information. The questionnaire covered such areas as cropping patterns and rotations, management practice (weeding, ridging, mounding, etc.), duration of fallow and cropping, labour availability and utilization, and land ownership and tenure and small-ruminant ownership.

Vaccination of Sheep and Goats

The major animal health input was administered in January 1984, with the vaccination of 687 sheep and

Table 2. Distribution of farms registered for alley farming in pilot villages, November 1983.

	Owu-Ile		Iwo-Ate	
	Forest	Savanna	Forest	Savanna
Cropped farms	20	11	10	17
Fallow farms	10	2	1	3
Total	30	13	11	20
Village total	43		31	
Grand total	74			

Table 3. Summary of animals vaccinated at two pilot villages, January 1984.

Vaccination records	Owu-Ile	Iwo-Ate	Total
Number of sheep vaccinated	91	24	115
Number of goats vaccinated	280	292	572
Total number of animals vaccinated	371	316	687
Number of small ruminant owners participating	108	114	222
Participants owning sheep (%)	34	12	-
Participants owning goats (%)	91	97	-
Number of animals/participant	3.4	2.8	-

goats with TCRV. A summary of the vaccination records is given in Table 3.

A follow-up vaccination exercise was conducted in May to cover animals that were not vaccinated in the first campaign. One hundred and sixty-nine farmers benefited from the exercise; more than 600 animals were vaccinated.

Vaccination was open to all inhabitants of the two villages, and, as a goodwill gesture, no fee was charged. It was later apparent that this "free service" had created some suspicion arising from a strong feeling among the farmers that "nothing goes for nothing." In the future, it may be advisable to charge a nominal fee for such services.

Land Preparation and Planting

Throughout February and March 1984, farmers were busy clearing and preparing their various farms for planting. ILCA senior technicians visited the site daily to inspect farm operations and exchange ideas with farmers. This was part of a strategy designed to gain their trust.

During the same period, two village meetings were held in each village to discuss planting arrangements and techniques with farmers. This was necessary as planting was to be done by the farmers without direct supervision. The discussions emphasized planting depth, seeding rate, and spatial and species arrangement for both arable and tree crops. In late March, after the meetings, planting demonstrations were organized by ILCA on two separate days in the two villages. At each village, the demonstration was held on one of the farmers' farms, and all farmers were encouraged to participate. Issues covered in the demonstration included estimation of spacing for the tree rows and alternation of Leucaena and Gliricidia rows. About 50 farmers from the two villages participated in the exercise. Tree seeds, 450 each of Leucaena and Gliricidia, were distributed to the farmers after the demonstration.

The farmers' interest was very much reflected by their response after the planting demonstration; most farms were planted 2-4 weeks later (Table 4). The

Table 4. Frequency distribution of planting dates of alley farms.

Planting date intervals (day/month)	Distribution of planting dates Owu-Ile	 Iwo-Ate
30/3 - 5/4 (1st WAD)[a]	11[b](2)[c]	1111(4)
6/4 - 12/4 (2nd WAD)	1111111(7)	1111111(7)
13/4 - 19/4 (3rd WAD)	11111111111(11)	111111(6)
20/4 - 26/4 (4th WAD)	111111111(9)	111111(6)
27/4 - 3/5 (5th WAD)	111(3)	11(2)
4/5 - 10/5 (6th WAD)	1(1)	1(1)
11/5 - 17/5 (7th WAD)	1(1)	
18/5 - 24/5 (8th WAD)	1111(4)	

[a] WAD = week after planting of demonstration farm.

[b] Single strokes indicate individual farms planted during the various time intervals.

[c] Figures in parentheses indicate total number of farms planted in each period.

farmers' willingness to take the necessary time from their normal farm operations to plant these "unknown" trees in their farms was seen as the first positive sign of the potential acceptability of the model. It showed that, given the right approach and a "farmer-relevant" proposal, farmers are willing, even without credit, to experiment with new ideas.

The exact number of farmers who planted the trees in their farms remained unknown for some time. This was because new alley farms were constantly being "discovered." Ten farmers, who initially did not register for the project, later obtained seeds and planting directions from their neighbours and planted their own alley farms - further evidence of the potential acceptability of the model - whereas about 15 others who obtained seed either failed to plant or abandoned the trees after planting. This latter group included individuals who joined the scheme in anticipation of some direct and immediate benefit, i.e., loans, compensations, etc., and who, therefore, dropped out when those benefits were not forthcoming.

Project Monitoring

As a result of the number of farmers participating in the project and the spatial distribution of the farms, effective monitoring requires a major input. The project has a postdoctoral fellow as coordinator and engages two senior technicians - one in charge of farm monitoring and the other concerned with the socioeconomic evaluation - and a junior technician on a full-time basis. Specific emphasis is placed by the socioeconomic technician on encouraging and documenting the participation of women in the project. A government extension technician, sponsored by the LPU and trained by ILCA, is also stationed in the village.

Each farm is visited at least twice a month by ILCA project personnel, who fill in open-ended, mainly unstructured report forms under four main headings: (a) crops, (b) trees, (c) farmers, and (d) things to be done. This is a way of systematically producing a picture of what is happening in the project, especially a picture of unexpected events, and of establishing the remaining program of research to be done on station.

So far, detailed animal monitoring has not been done. This is because the first year of the project was primarily a tree-planting and establishment year. Monitoring activities, therefore, concentrated on the establishment and management of the trees by the farmer. Data on participating farmers' ownership of small ruminants were collected as part of the baseline survey. A livestock inventory was initiated in January 1985 and will be completed at regular monthly intervals to enable ILCA to monitor flock sizes. The inventory exercise will aim at comparing animals receiving browse supplementation from alley farms with a control group of "no-browse" animals. In each village, 10 alley farming and 10 nonalley farming households have been randomly selected for this purpose. All animals in the households will be monitored to show flock build-up and off-take trends.

A significant socioeconomic objective of the monitoring exercise is to define the client population for the alley farming model more precisely. The monitoring is, therefore, concerned with explaining the contrasting participation of particular categories of people, such as men and women, citizens and strangers (Okali 1984).

RESULTS AND DISCUSSION

It is essential that this kind of research development project is continually evaluated. It must, however, be emphasized that the objectives of the evaluation exercise should not be seen as obtaining statistically approved data on crop yields, tree growth, etc., but to see whether the alley farming model is practicable under farming conditions, whether it is accepted by farmers, and what modifications made by the farmers have enhanced the workability of the system. The evaluation will also look at the effect of the different farmer-management situations on the establishment and growth of the trees.

The first evaluation of the planted alley farms, based on germination/emergence, spatial arrangement of the trees, and the general condition of the farms and their management, was carried out starting 6 weeks after planting commenced. A second evaluation was conducted in August at the end of the first cropping season. The evaluation team consisted of two agronomists, one socioeconomist (all senior scientists), and one animal technician. The exercise was to be carried out every 2 months during the first year.

In the evaluations, each farm was scored for "probability of successful establishment" by four ILCA personnel. The scoring scheme was as follows: 1 - poor, 2 - fair, 3 - good, and 4 - excellent.

Food crops growing with the trees were also noted. The most common crop/crop combinations were maize, maize/cassava, and yam. A summary of the ratings is given in Table 5. At the first evaluation, yam appeared to be a better establishment crop than

Table 5. Summary of initial evaluations of alley farms in the LPU pilot project.

Crop	Time of assessment	Number of farms	Potential for establishment (%)				Total (%)[c]
			Poor	Fair	Good	Excellent	
Maize	FA[a]	19	21	26	37	16	100
	SA[b]	21	24	24	43	9	100
Maize/cassava	FA	15	27	20	47	7	100
	SA	16	19	37	38	6	100
Yam	FA	19	11	11	42	37	100
	SA	14	14	22	50	14	100
Other	FA	7	14	43	29	14	100
	SA	12	17	33	17	33	100
Total	FA	60	18	22	40	20	100
	SA	63	19	29	38	14	100

[a] FA = first assessment, June 1984.

[b] SA = second assessment, August 1984.

[c] Percentage values are based on the number of farms in each row.

maize or maize/cassava, because its sprouts developed slowly and, therefore, allowed maximum light for the tree seedlings. However, because yam was unstaked in most farms, intense shading and competition with the young trees resulted.

In all, 60 farms, planted by 28 May, were evaluated in the first exercise. Sixty percent were considered to have either good or excellent potential for establishment, while 22% were fair and 18% poor. Of 63 farms inspected in the follow-up evaluation, 19% were rated excellent, 29% good, 38% fair, and 14% were considered to have poor potential for establishment. This evaluation exercise will be conducted periodically to allow for continuous assessment.

By the end of the second year, a sample of farms and farmers will be analyzed independently, and case studies will be developed based on specific management and environmental situations. This will help identify factors and circumstances influencing the establishment of alley farms and the system's practicability under different management and environmental conditions.

It is also intended that some data will be obtained through structured interviews or direct observation to answer such questions as: (a) Why did adopters adopt? (b) Why did nonadopters not adopt? (c) Why did adopters who abandoned their farms give up? (d) What use is made of the browse trees? This is also intended as a guide for future work. It is recognized that the final evaluation and assessment of the project is carried out by the farmer, who will decide whether or not the proposed intervention is relevant and workable. This evaluation by the farmer can be measured in terms of the rate and percentage of adoption and the readiness and efficiency with which other farmers pick up the technology.

CONCLUSION

The project has so far run very much according to schedule, and considerable progress has been made. The major success achieved so far should be seen not in the establishment of the farms per se, but in the level of cooperation and understanding that has been achieved between the farmers and ILCA.

A number of farms had their first cutting after only 6-7 months of growth. On most farms, trees will be cut for the first time at the beginning of the main season planting of 1985. All foliage from the first cutting will be used as mulch. Subsequent regrowth will be harvested periodically and used as mulch and cut-and-carry feed for the farmers' sheep and goats.

Field days, village meetings, and tours will be organized to demonstrate and discuss management and utilization of the trees to ensure their proper usage. It is expected that the project will make a significant impact on the total farming system of the small farmer by improving food and small-ruminant production. The monitoring will form the basis for small-ruminant development strategies of national agencies throughout the humid zone. These strategies would be based on disease control and feed production using fast-growing leguminous trees.

REFERENCES

Atta-Krah, A.N. 1983. Evaluation of village alley farms. Ibadan, Nigeria, International Livestock Centre for Africa (ILCA), Humid Zone Programme, Programme Document No. 9, 8 p.

Kang, B.T., Wilson, G.F., and Sipkens, L. 1981. Alley cropping maize (Zea mays L.) and Leucaena (Leucaena leucocephala) Lam) in southern Nigeria. Plant and Soil, 63, 165-179.

Okali, C. 1984. Community response to a pilot alley farming project. Ibadan, Nigeria, International Livestock Centre for Africa (ILCA).

Sumberg, J.E. 1984. Small ruminant feed production in a farming systems context. Paper prepared for the Workshop on Small Ruminant Production Systems in the Humid Zone of West Africa, 23-26 January 1984, Ibadan, Nigeria. (In press)

Wilson, G.F. and Kang, B.T. 1980. Developing stable and productive cropping systems for the humid tropics. Proceedings of the Conference on Biological Agriculture, Wye College, London, 22-26 August 1980. London, England, Wye College.

FARMERS' RESPONSES TO THREE SUMMER FORAGES IN THE NILE DELTA

I.M. Soliman,[1] E.A. Khafagi,[1] M.E. Saleh Youssef,[1] M.K. Hathout,[1] and A.A. Moussa[2]

[1]Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt, and [2]Agricultural Economics and Statistics Research Institute, Dokki, Giza, Egypt

Abstract *The objective of a study carried out on 31 small farms in two centres of Monofia Governorate in the Nile Delta was to evaluate some summer forages that have recently been introduced in the country, specifically, Elephant grass and Sordan grass, compared with the traditional Darawa, concerning their productivity, nutritive value, and economic returns to the farmers.*

Darawa occupied 52%, Sordan 25%, and Elephant grass 23% of the cultivated plots of summer forages. The average total fresh yield was 24.03, 58.59, and 87.44 t/feddan (1 feddan = 4200 m^2), for the three forages, respectively.

On a dry matter basis, the average crude protein, crude fibre, and ash contents were 11.92, 32.08, and 10.72% for Darawa; 12.29, 36.13, and 12.18% for Sordan; and 13.17, 31.56, and 16.77%, respectively for Elephant grass. The nutritive value, expressed in terms of in vitro dry matter digestibility (IVDMD) was 63.43, 53.52, and 60.53%, for Darawa, Sordan, and Elephant grass, respectively.

The total cost of agricultural operations per feddan was 272, 478, and 569 EGP, (1 US$ = 1.25 Egyptian pounds (EGP)) for Darawa, Sordan, and Elephant grass, respectively. Elephant grass ranked first, with respect to cash return per feddan (480 EGP) and Sordan grass second (272 EGP), whereas Darawa gave the least return (209 EGP) from its sole plantation.

Farmers' attitudes toward the feasibility of growing and utilizing the new summer forages were also presented.

Résumé *L'étude menée dans 31 petites exploitations de deux centres du gouvernorat de Monofia, dans le delta du Nil, voulait évaluer certains fourrages d'été récemment introduits dans le pays, particulièrement l'herbe à éléphant et l'herbe hybride du Soudan (sordan), à comparer avec le maïs fourrager traditionnel (darawa). L'étude a porté sur leur productivité, leur valeur nutritive et les revenus que l'exploitant en tire.*

Dans les parcelles plantées en fourrage d'été, le darawa occupait 52 %, le sordan, 25 % et l'herbe à éléphant, 23 %. Le rendement moyen total en fourrage vert a été de 24,03, 58,59 et 87,44 t/feddan pour les trois fourrages respectivement, 1 feddan valant 4200 m^2*. Le rendement moyen total correspondant en matière sèche a été de 5,96, 14,53 et 15,82 t/feddan.*

Les teneurs de la matière sèche en protéine brute, en fibre brute et en cendre étaient, en moyenne, de 11,92 %, 32,08 % et 10,72 % respectivement pour le darawa; de 12,29 %, 36,13 % et 12,18 % pour le sordan; de 13,17 %, 31,56 % et 16,77 % pour l'herbe à éléphant. La valeur nutritive, mesurée en termes de digestibilité de la matière sèche en milieu artificiel, a été de 63,43 %, 53,52 % et 60,53 % respectivement.

Le coût total des activités agricoles pour 1 feddan a été, pour le darawa, le sordan et l'herbe à éléphant respectivement, de 272, 478 et 569 livres égyptiennes, 1,25 livre valant 1 $US. Quant aux revenus tirés par feddan, l'herbe à éléphant est venu au premier rang (480 livres), suivi du sordan (272 livres); l'unique plantation de darawa n'a donné que 209 livres. Enfin, l'étude a aussi fait état des réactions des agriculteurs à la possibilité de cultiver et d'utiliser les nouveaux fourrages d'été.

In Egypt, animals suffer from underfeeding and malnutrition during the summer season because of the shortage of feedstuffs. A limited area of about 100,000 feddans (1 feddan = 4200 m^2) is cultivated annually with summer forages mainly maize forage (Darawa), while during winter about 2.75×10^6 feddans are cultivated with Egyptian clover (Berseem), according to the 1976 census. Egyptian clover, Berseem (Trifolium alexandrinum), is considered to be the most important winter forage on which livestock feeding depends, especially for milk and meat production. It gives 3-4 cuts during the winter and spring seasons. The annual cultivated area of (Miskawy) Berseem was about 1.76 x 10^6 feddans, according to the 1980 census.

The area cultivated with temporary Berseem (Fahl), giving one cut before cotton cultivation, was continuously decreasing. In 1980, it reached a minimum of about 990,000 feddans. The alfalfa area had 22,000 feddans according to the same census. The area cultivated with different summer forages, however, was about 100,000 feddans. Good-quality summer forages (Elephant grass and sorghum) were included in the agricultural rotation to improve the nutritional status of animals during the summer season. A Sudan grass hybrid (Sordan) has been introduced to Egypt as a potentially high-productive forage crop. These forages are believed to have better productivity and feeding quality than the traditional maize forage (Darawa). Controlled agronomic and feeding experiments conducted by the summer forage crops staff have indicated the validity of this statement. The government encourages the farmers to cultivate new summer forages like Sordan by selling their seeds at low prices. Moreover, 1 kg of these seeds (Sordan) is given freely to farmers for each feddan cultivated with maize to avoid defoliation and detasseling of maize plants. Consequently, one-third of the maize grain yield is saved (El-Tobgy 1976) and a considerable amount of good summer forage is available for animals during the critical summer period.

The objective of this investigation was to evaluate the productivity and the nutritive value of the summer forages, Elephant grass and Sordan grass, versus that of traditional summer forage (Darawa), when cultivated by small farmers, and to measure their response and economic returns to the smallholders.

MATERIALS AND METHODS

The study included 31 small farms, distributed in the two centres of Tala and Shebeen in Monofia Governorate, which is located in the middle of the Nile Delta (lower Egypt) and is characterized by smallholdings.

Monofia Governorate has a human population of about 1.9 x 10^6 (according to the 1980 census), and most inhabitants have received formal education. Farmers are active, broadminded, and are always ready to accept and apply new technologies in agriculture. Monofia Governorate occupied a relatively small area in the Nile Delta, which amounts to 325,846 feddans out of 4,738,514 feddans for the governorates of the Delta. Its soil is considered to be the most fertile in the country. The animal population consists of the following numbers (according to the 1980 census): buffalo, 221,644; cattle, 154,450; sheep, 119,191; goats, 106,965; horses, mules, and donkeys, 177,023; and camels, 11,321.

Monofia, one of the 24 governorates of Egypt, is divided into administrative centres. Two of these centres, Tala and Shebeen, were chosen to be the study area because they are small and represent the majority of the farms of this governorate.

Twelve villages were chosen, six in each centre, Kamaisha, Kafr Sleem, Kafr Alawee, Kafr Rabee, Shobra Btoosh, and Tookh Delka villages are located in Tala centre. Yanbus, Bakhati, Meet Khalkan, Manshiet Kasem, Shebeen, and Tanbady are located in Shebeen centre. Two to four farms were selected for the study from each village, for a total of 31 farms, which cultivated 56 plots with summer forages.

Two animal production specialists of the Animal Production Research Institute, resident in Shebeen and Tala, were used as contacts in Monofia Governorate in farmer selection. Together with the research team they conducted an informal reconnaissance of the governorate to ensure that the two centres chosen were representative of farmers in the governorate. They selected the 31 farmers because they were familiar with farmers in this area. The data presented in Table 1 show the distribution of areas and plots cultivated with summer forages in the 31 farms; only one farmer cultivated the three summer forages on his farm, whereas seven farmers preferred to grow only one forage, either Darawa or Elephant grass. However, the majority of the farmers cultivated two forages, mainly Darawa (13 farmers) and either Sordan grass or Elephant grass (10 farmers). Accordingly, Darawa, Sordan grass, and

Table 1. Identification of farms, number of plots, and frequency distribution of cultivated areas for three types of summer forages.

No. of farms	No. of plots Elephant grass	Sordan grass	Darawa	Total plots
1	1	1	1	3
10	10	-	10	20
13	-	13	13	26
5	-	-	5	5
2	2	-	-	2
Total 31	13	14	29	56
Areas (kirat)[a]				
1-6	8	11	28	47
7-12	-	2	-	2
13-18	-	1	-	1
19-24	3	-	1	4
25-30	-	-	-	-
31-36	2	-	-	2
Total	13	14	29	56

[a] 1 kirat = 175 m^2.

Elephant grass were cultivated in 29, 14, and 13 plots, representing 52, 25, and 23% of the total, respectively.

Farmers agreed to grow these forages without incentives on the condition that Elephant grass be grown as an annual. The farmers provided all production inputs in forage production. Thus, no formal agreement with the farmers was necessary.

The area of the plot ranged from 1 kirat to 1.5 feddans.[1] Most of the plots (84%) had a small area ranging from 1 to 6 kirats. Only nine plots out of 56 had a bigger area ranging from 7 to 36 kirats.

A group of project research staff accompanied by three field officers visited the farms weekly during the period from April to October 1984. They supplied the farmers with the necessary instructions and recommendations concerning the cultivation, fertilization, irrigation, and harvesting of the forages at the proper stage of maturity, when their composition and nutritive value are best.

The cultivation of temporary Elephant grass was concentrated early in April, whereas Sordan grass and Darawa were mostly cultivated during May. Darawa seeds were obtained from the public sector, but, unfortunately, they were infected with insects, therefore, a low germination percentage resulted. Consequently, the cultivation was repeated using new seeds bought by the project staff and offered freely to the farmers. Elephant grass plantations were obtained from both private and public sectors.

The seeding rate was 20 and 60 kg/feddan, for Sordan grass and Darawa, respectively, whereas Elephant grass was planted in rows at distances of 70 cm. A feddan contained about 10,000 clumps on average.

Fertilization was carried out using manure, superphosphate, nitrate, and urea, according to the recommendations of the Ministry of Agriculture. Elephant grass gave as much as seven cuts during the whole season, whereas Sordan grass gave four major cuts. As for Darawa, it gave only one cut from its plantation.

---

[1] 1 kirat = 175 m^2, 1 feddan = 4200 m^2 (24 kirats), and 1 hectare = 10,000 m^2 (60 kirats).

The sole cut of Darawa and the first cut of Sordan grass were each taken at least 45 days after cultivation to avoid the toxicity effect of their high hydrocyanic acid content during the early stage of their growth, but the following cuts of Sordan grass were taken every month. All cuts of Elephant grass were taken when the grass reached 100 cm in height.

All necessary work on the farms involving cultivation, irrigation, fertilization, and harvesting was completed by the smallholders and their families. Cutting the forages to obtain the representative samples for analysis was accomplished by the team of nutrition researchers.

The yield per feddan of the investigated forages was determined at the time of harvest. For measuring the fresh yield per cut per feddan for both Sordan grass and Darawa, the average weight of plants harvested from two areas of 1 m^2 each, chosen at random in each plot, was multiplied by 4000. As for Elephant grass, when the plants reached 1 m in height, 10 clumps were randomly chosen in each plot, cut and weighed, then their total weight was multiplied by 1000 to obtain the fresh yield per cut per feddan, on the basis that a feddan contained about 10,000 clumps on the average.

In each cut, a fresh sample of forage weighing about 2 kg, representing the yield of 2 m^2 of Sordan grass or Darawa and the yield of 10 clumps of Elephant grass, was taken for dry matter determination, which was carried out at 70°C for 16 hours in the Shebeen laboratory in Monofia Governorate. The dried forage samples were then transferred to the Central Laboratory of the Animal Production Research Institute at Dokki for chemical analysis that was carried out according to Association of Official Analytical Chemists (AOAC) methods (AOAC 1980). In addition, the nutritive value of the forage samples was determined in terms of in vitro dry matter digestibility (IVDMD) according to Tilley and Terry (1963).

On-farm measurements, feed intake, and animal performance were collected through a questionnaire designed by the economic research team. Farm animals were from local breeds in Egypt, including buffalo, Baladi cattle, sheep, and goats. All animals belonged to the farmers who had from one to three animals.

For the economic evaluation of the investigated summer forages, a questionnaire of 10 pages in Arabic was designed to collect data from the 31 smallholders. An economic team of three researchers was responsible for visiting the farmers periodically to collect the economic data. One of them joined the members of the nutrition team on their weekly visits also. Intensive visits of the three economic researchers were accomplished during the last month of the summer season. The questionnaire covered the following information:

(a) Farming system and area of summer forages;

(b) Number and type of livestock raised on the farm;

(c) Consumption of feeds, including green forages, dry roughages, and concentrates;

(d) Milk and meat production on the farm;

(e) Yields of summer forages;

(f) Costs of agricultural operations for cultivation and management of summer forages;

(g) Costs of management and feeding animals; and

(h) Farmers' attitudes toward the cultivation of new summer forages and the problems facing them.

RESULTS AND DISCUSSION

Productivity of Summer Forages

The average yield of the three summer forages as fresh and dry matter in tonnes per feddan for each cut and for the whole season is given in Table 2. The data indicated that the total fresh yield of Elephant grass

Table 2. Average fresh and dry matter yields of summer forages.

Forages	No. of farms	Average of cuts	Average total yield/feddan(t)[a]		Average yield/cut (t)	
			Fresh	Dry	Fresh	Dry
Elephant grass	13	4.14	87.44	15.82	21.12	3.82
Sordan grass	14	2.68	58.59	14.53	21.86	5.42
Darawa	29	1.00	24.03	5.86	24.03	5.96

[a] 1 feddan = 4200 m^2.

was nearly 1.5 times that of Sordan grass, whereas it was about 3.5 times that of the sole cut of Darawa. The total dry matter yield of Elephant grass was slightly higher than that of Sordan grass, whereas Darawa yielded about 30% of that produced by either of the other two forages. Concerning the average dry matter yield per cut per feddan, Elephant grass gave about 30% less dry matter than Sordan grass, but Darawa was slightly higher than Sordan grass in that respect.

The present results for the average productivity of Elephant grass was 87.44 t/feddan as fresh yield. This was slightly lower than that recorded by Fahmy (1978) as 90 t/feddan and remarkably lower than the figure of 100 t/feddan as reported by Gabra (1980) for loamy soil. Hassan and Gabra (1982) reported that Elephant grass planted in sandy soils gave 65.4 t/feddan. For Sordan productivity, Gabra (1984) recorded 41 t/feddan, which is far lower than that obtained in the present study of 58.59 t/feddan. The average height recorded for both studies was about 125 cm.

Chemical Composition and Dry Matter Digestibility of Summer Forages

The results of the chemical analysis and the in vitro dry matter digestibility of the different cuts and farms of the three summer forages are presented in Table 3.

The average chemical composition showed that Elephant grass was the highest in crude protein, ash, calcium, and phosphorus content but was the lowest in dry matter (DM), ether extract (EE), crude fibre (CF), and nitrogen-free extract (NFE). Darawa, however, had the minimum contents of crude protein, ash, calcium, and phosphorus, but it attained the maximum contents of EE and NFE. Sordan grass was intermediate in all nutrients, but it attained the highest CF content and had similar DM content as that of Darawa.

The present results showed that the average CP, EE, CF, and ash contents of Elephant and Sordan grasses were higher than those obtained by Khafagi et al. (1983) and Gabra (1984). The average proximate composition of Darawa was also higher than that published by the Ministry of Agriculture (1968). The

Table 3. Average composition and dry matter digestibility of the summer forages.

Cut no.	No. of farms	Proximate composition (%)a						Mineral content (%)a			In vitro DMD (%)
		DM	CP	EE	CF	NFE	Ash	Calcium	Phosphate	C:P	
Elephant grass											
1	8	16.89	12.17	2.64	31.54	36.90	16.75	0.23	0.35	0.66:1	58.88
2	13	16.82	14.38	2.82	31.77	33.19	17.84	0.36	0.37	0.97:1	61.90
3	12	19.10	12.38	2.65	31.47	37.80	15.70	0.31	0.42	0.74:1	60.44
4	9	18.08	13.40	2.62	31.47	35.21	17.30	0.39	0.34	1.15:1	60.33
5	6	18.40	11.99	2.70	32.71	36.59	16.01	0.34	0.37	0.92:1	60.63
6	3	19.33	15.68	2.82	29.31	35.55	16.64	0.30	0.33	0.91:1	60.50
7	1	18.00	11.29	2.10	30.38	41.30	14.93	0.65	0.34	1.91:1	57.10
Average		18.09	13.17	2.69	31.56	35.81	16.77	0.33	0.37	0.89:1	60.53
Sordan grass											
1	14	26.04	13.23	2.93	36.39	36.01	11.44	0.24	0.19	1.26:1	51.58
2	14	23.36	11.66	2.64	35.67	37.46	12.57	0.30	0.40	0.75:1	53.96
3	11	21.77	11.63	2.79	36.56	37.21	11.81	0.23	0.22	1.05:1	54.23
4	4	28.04	13.54	2.61	36.01	33.73	14.11	0.28	0.28	1:1	56.45
Average		24.80	12.29	2.76	36.13	36.64	12.18	0.26	0.28	0.93:1	53.52

(continued)

Table 3. Concluded.

Cut no.	No. of farms	Proximate composition (%)[a] DM	CP	EE	CF	NFE	Ash	Mineral content (%)[a] Calcium	Phosphate	C:P	In vitro DMD (%)
Darawa grass											
Average		24.80	11.92	3.03	32.08	42.25	10.72	0.248	0.271	0.92:1	63.43
Min.	1	39.00	5.69	2.24	27.63	33.48	8.22	0.070	0.090	0.78:1	55.70
Max.	29	13.70	20.83	4.07	37.76	51.81	16.92	0.630	0.930	0.68:1	73.59

Note: DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract; C, calcium; P, phosphorus; and DMD, dry matter digestibility.

[a] Percentage of dry matter.

nutritive value of the forages, expressed in terms of in vitro dry matter digestibility (IVDMD), showed that Darawa was slightly better than Elephant grass, whereas Sordan grass was the least in that respect.

The IVDMD of Elephant grass in this study was much the same as the in vivo DMD obtained by Khafagi et al. (1983) and Gabra (1984). But the IVDMD of Sordan grass was significantly lower than the in vivo DMD found by Ademosum et al. (1968), Khafagi et al. (1983), and Gabra (1984).

Economic Evaluation of Summer Forages

The data presented in Table 4 show the averages for the yield per feddan and the value and costs of production and the net return, excluding rental cost, from cultivating the three summer forages.

The data indicated that Elephant grass ranked first with respect to cash return per feddan and Sordan grass ranked second, whereas Darawa gave the least return from its single cut. For the cost of production per ton of fresh forage, Sordan grass was more costly than Elephant grass, but Darawa was very expensive.

Farmers' Attitudes Toward New Summer Forages

Table 5 illustrates in brief the farmers' attitudes, obtained from the questionnaire, toward the new summer forages by focusing on their reasons for cultivating them and on some of the problems they faced during the summer season of 1983. For example:

(a) The cultivation of Elephant grass was concentrated in early April, whereas Sordan grass and Darawa were mostly cultivated during May.

(b) Darawa seeds were obtained from the private sector, but Sordan grass seeds were obtained from the public sector and Elephant grass was obtained from both the private and the public sectors.

(c) Elephant grass gave as much as six cuts during the whole season, Sordan grass gave four major cuts, and Darawa was seeded once to give its sole cut.

Table 4. Average value and costs of production and net return for summer forages.

Forages	Average fresh yield t/feddan[a]	Price/t (EGP)[b]	Total value (EGP)	Total cost (EGP)	Net return (EGP)	Cost of producing 1 t (EGP)
Elephant grass	87.44	12.0	1049	569	480	6.51
Sordan grass	58.59	12.8	750	478	272	8.19
Darawa (one cut)	24.03	20.0	481	272	209	11.32

[a] 1 feddan = 4200 m^2.
[b] 1 US$ = 1.25 Egyptian pounds (EGP).

Table 5. Reasons for cultivation of new summer forages and problems facing farmers.

Reasons for cultivation	Frequency	Problems	Frequency
Elephant grass			
Insufficiency of concentrates and straws	4	High labour cost	4
High productivity and palatability	3	Difficulty in removing clumps	3
Improves animal performance	3	High cost of removing clumps	2
Increases rate of growth	2	A part of land is occupied with stored clumps for next season	1
Reduces fattening costs	1	First cut sometimes causes bloat	1
		Scarcity of labour	1
		Cultivation needs approval of agricultural cooperative	1

(continued)

Table 5. Concluded.

Reasons for cultivation	Frequency	Problems	Frequency
Sordan grass			
A new trial worthy of attention	4	No problems	4
Improves animal performance	4	Unavailability of seeds at proper time	3
Yields several cuts	2		
Saves other types of feedstuffs	2	Low germination percentage due to seeds infection	3
Reduces production costs	2	Waste in feeding is great	3
		High labour cost	1

(d) The time required to harvest 1 kirat of forage ranged from 2.5 to 2.9 hours for Elephant grass, 2.2-2.4 hours for Sordan grass, and 2.5 hours on the average for Darawa.

(e) Both Elephant grass and Sordan grass had a positive impact on the performance of lactating and growing animals. In addition, larger herd size on the farm was associated with the availability of these grasses.

(f) The yield of 3 kirats of either Elephant grass or Sordan grass was sufficient to feed a dairy cow, of moderate production, during the summer season without additional feedstuffs. Darawa, on the other hand, required 4 kirats for this purpose. As for a dairy buffalo of moderate production, it was maintained on a yield of 4 kirats of either Elephant grass or Sordan grass or the yield of 5.5 kirats of Darawa.

(g) Concerning the impact of introducing summer forages in the practice of maize defoliation and detasseling and the effect of such a practice on grain production, 23 farmers out of 31 stated that they found no need for such a practice in the presence of plenty of summer forage and, as a result, they obtained more maize grain yield.

(h) It is a normal practice in the villages for farmers to sell any excess production of Darawa to their neighbours, but such is not the case for the new summer forages of Elephant grass and Sordan grass.

REFERENCES

Ademosum, A.A., Banmgardt, B.R., and Scholl, J.M. 1968. Evaluation of Sorghum-Sudan grass hybrid at varying stages of maturity on the basis of intake, digestibility and chemical composition. Journal of Animal Science, 27, 818.

Agricultural Economics and Statistics Research Institute, Ministry of Agriculture. 1976. Annual report, 1976. Cairo, Egypt, Agricultural Economics and Statistics Research Institute, Ministry of Agriculture.

Association of Official Analytical Chemists (AOAC). 1980. Official methods of analysis of the Association of Official Analytical Chemists. Washington, DC, USA, AOAC, 13th edition.

El-Tobgy, H. 1976. Contemporary Egyptian agriculture. Cairo, Egypt, The Ford Foundation, Middle East Regional Office, 2nd edition.

Fahmy, A.A. 1978. Effect of feeding Elephant grass on the growth of sheep. Egypt, El-Minia University, Faculty of Agriculture. (MSc thesis paper)

Gabra, M.A. 1980. Some nutritional studies on Napier grass. Cairo, Egypt, Cairo University, Faculty of Agriculture. (MSc thesis paper)

1984. Studies on the productivity and feeding qualities of some annual and perennial forages as affected by some agronomic practices fed to sheep in metabolism trials including nutritional balances. Cairo, Egypt, Cairo University, Faculty of Agriculture. (PhD thesis paper)

Hassan, A.K. and Gabra, M.A. 1982. Effect of interseeding cowpea on green fodder and grain yield of Sorghum. Egypt, Zagazig University, Faculty of Agriculture, Bulletin no. 542.

Khafagi, E.A. 1983. Comparative study for the evaluation of some summer forages. Proceedings of the 2nd Conference of the Agricultural Research Centre. Cairo, Egypt, Agricultural Research Centre. (In press)

Ministry of Agriculture. 1968. Animal and poultry nutrition. Cairo, Egypt, Animal Production Research Institute, Agricultural Research Centre. (In Arabic)

Tilley, J.M.A. and Terry, R.A. 1963. A two-stage technique for in vitro digestion of forage crops. Journal of the British Grasslands Society, 18, 104-111.

ON-FARM TRIALS WITH DUAL-PURPOSE GOATS ON SMALL FARMS IN WESTERN KENYA

**A.E. Sidahmed,[1,2] J.F.M. Onim,[1,2] A.W. Mukhebi,[1,2]
R.S. Shavulimo,[1,3] A.J. De Boer,[1,3] and
H.A. Fitzhugh[1,2]**

[1]Small Ruminant-Collaborative Research Support
Program (SR-CRSP), P.O. Box 252, Maseno, Kenya,
[2]Winrock International, Morrilton, AR 72110-9537 USA,
and [3]Ministry of Agriculture and Livestock
Development, Kenya

Abstract *The objective of the Small Ruminant-Collaborative Research Support Program (SR-CRSP) in Kenya is to develop and evaluate dual-purpose goat (DPG) production systems for limited resource farmers. Farming systems research methodologies are undertaken by a multidisciplinary team of scientists. Stage 1 involved characterization of target farming systems and on-station component research. Stage 2 combined on-station research with scientist-managed on-farm trials. Stage 3 will involve large-scale monitoring on farms of DPG production systems based on packaged technologies developed in Stage 2.*

A random sample of 80 farmers was selected from a larger national sample of small-scale farmers in western Kenya. Few DPG were placed initially. As more goats became available more respondent farmers and more DPGs per farm were added to the trials. On-farm monitoring included bi-weekly visits by senior scientists and weekly visits by trained field technicians fluent in local languages. Data on DPG performance variables, such as nursing and milking systems, diet selection and intake from uncultivated lands, body weight changes, and dietary overlap and competition between DPG and other livestock on-farm, were collected using questionnaires, experimental observations, and formal and informal farmer interviews. Collected data were discussed in weekly meetings of research scientists and

field technicians before recording in a computer for analysis of technical feasibility, economic viability, and social compatibility for the DPG technology in the small-scale farming systems.

Résumé *L'objectif du Small Ruminant-Collaborative Research Support Program (SR-CRSP), au Kenya, consiste dans la mise au point et l'évaluation de systèmes de production de chèvres à double fin (CDF) pour les exploitants dont les ressources sont limitées. La méthodologie de la recherche sur les systèmes d'exploitation agricole est sous la responsabilité d'une équipe multidisciplinaire de scientifiques. L'objectif de la phase 1 a été de définir les systèmes d'exploitation à étudier et les éléments à incorporer à la recherche en station. Dans la phase 2, la recherche en station a été associée aux essais sur le terrain dirigés par les scientifiques. La phase 3 comportera l'observation, sur une grande échelle, de l'exploitation des systèmes de production de CDF utilisant les enveloppes technologiques mises au point lors de la phase 2.*

À partir d'un vaste échantillon national de petits exploitants agricoles du Kenya occidental, on a choisi au hasard un échantillon de 80 agriculteurs. On a distribué peu de CDF au début. Le nombre de chèvres disponibles augmentant, plus d'agriculteurs et plus de CDF par exploitation vinrent s'ajouter aux essais. L'observation sur le terrain a comporté des visites bi-hebdomadaires des scientifiques principaux, et des visites hebdomadaires des techniciens de terrain dûment formés et parlant couramment les langues locales. On a rassemblé des données sur les variables de performance des CDF : les systèmes d'allaitement et de traite, le choix d'une ration et les aliments consommés sur des terres non cultivées, les fluctuations dans le poids, le chevauchement des rations alimentaires et la concurrence entre les CDF et les autres animaux sur le terrain. Pour ce faire, on a utilisé le questionnaire, l'observation, et l'interview, formel ou non, des agriculteurs. Les chercheurs et les techniciens de terrain, lors de leurs réunions hebdomadaires, ont discuté des données avant de les traiter par ordinateur afin d'analyser la faisabilité technique, la viabilité économique et l'acceptabilité sociale de la technologie de CDF pour les petits agriculteurs.

Farm families in western Kenya have limited resources (farm size of approximately 1 ha) to produce food and income. The Small Ruminant-Collaborative Research Support Program (SR-CRSP)[1] is evaluating the dual-purpose goat (DPG) as a source of milk to provide a protein supplement to the family diet and slaughter stock to provide income. Farming systems research (FSR) is conducted by a multidisciplinary team to develop and evaluate DPG production systems.

Initially, the existing farming systems of western Kenya were surveyed and biological and socioeconomic components analyzed (Sands et al. 1983; Campbell et al. 1984). The characterization phase was conducted from October 1980 to December 1982 on 40 farms in two village clusters in Kakamega district and 40 farms in two villages in Siaya district. Results were instrumental in setting research priorities. Research activities and implementation strategies are detailed in Fig. 1.

A three-stage process has been followed in the research:

Stage 1: On-station component research, monitoring of a limited number of DPG placed on farms, and continuing characterization of socioeconomic factors (Brown et al. 1983a; Boor et al. 1984; and Reynolds et al. 1984).

Stage 2: Continuing on-station research, scientists managed on-farm trials, on-farm production of DPGs, and an expanded on-farm performance monitoring program (Brown and Nderito 1983; Ruvuna et al. 1983; Brown et al. 1984a; Cartwright et al. 1984; Rurangirwa et al. 1984; and Salim et al. 1984).

---

[1] SR-CRSP activities are supported by the Kenya Ministry of Agriculture and Livestock Development (MALD), by the U.S. Agency for International Development (USAID), and by U.S. institutions (Breeding and Systems Analysis, Texas A & M University; Sociology, University of Missouri; Animal Health, Washington State University; Economics, Nutrition-Management and Feed Resources, Winrock International).

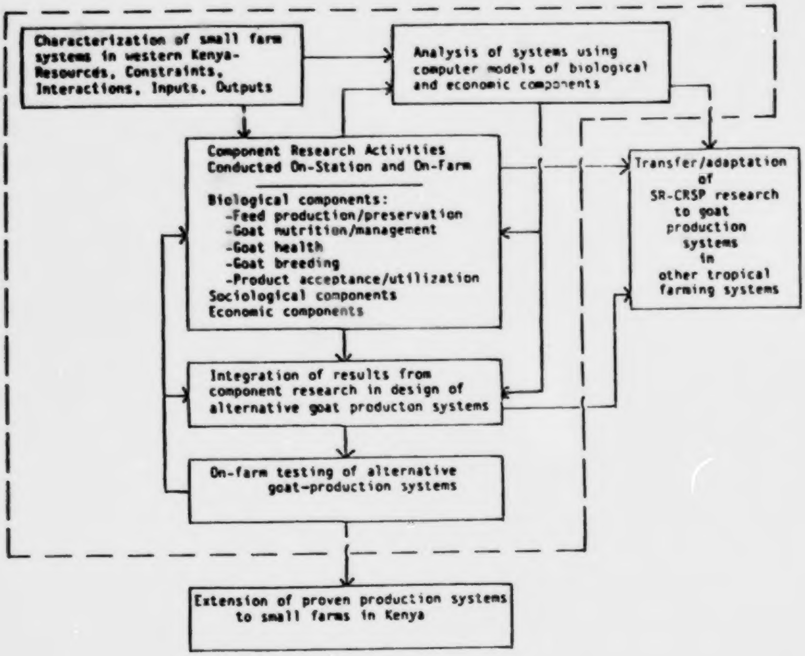

Characterization of small farm systems in western Kenya- Resources, Constraints, Interactions, Inputs, Outputs
Analysis of systems using computer models of biological and economic components
Component Research Activities Conducted On-Station and On-Farm
Biological components:
-Feed production/preservation
-Goat nutrition/management
-Goat health
-Goat breeding
-Product acceptance/utilization
Sociological components
Economic components
Transfer/adaptation of SR-CRSP research to goat production systems in other tropical farming systems
Integration of results from component research in design of alternative goat producton systems
On-farm testing of alternative goat-production systems
Extension of proven production systems to small farms in Kenya

Fig. 1. Implementation strategy for SR-CRSP research activities involving dual-purpose goat production systems for small farms in Kenya.

Stage 3: This stage will involve extensive on-farm evaluation of DPG systems based on packaged technologies developed in Stage 2. Researchers will monitor adaptation and changes in recommended packages by farmers.

MATERIALS AND METHODS

Description of Research Sites

The Small Farm Systems Survey and consequent introduction and testing of the DGP technology was conducted in Kakamega district and Siaya district of Nyanza Provinces. The area under study is located in the Lake Victoria Basin 400 km west of Nairobi and 100 km east of the Uganda border.

Kakamega district is classified agriculturally as a high potential area with bimodal rainfall ranging between 1750 and 2100 mm/year. The altitude ranges between 1400 and 1800 m. The most important food crops are maize and phaseolus beans, usually intercropped. Other food crops include sorghum, cassava, sweet potatoes, and bananas. Principal cash crops are coffee, tea, and trees. Principal livestock species are grade and Zebu cattle, hair sheep, East African goats, and poultry. The dominant tribe in the rural areas of Kakamega are the Abaluhya. The 1979 census estimated that the district population was about 1,033,000. There is an extremely high land pressure of 328 people/km^2. In some parts of the district, density is as high as 880 people/km^2.

Siaya district is considered a medium potential zone. Rainfall is bimodally distributed with an annual mean of 1000-1300 mm. The altitude ranges from 1140 to 1500 m. Natural vegetation is dominated by invasive shrubs and trees (e.g., Albizia, Soriana, and Lantana species) and a mixture of grasses including species of Hyparrhenia, Cymbogon, Brachiaria, Cynodon, Panicum, and Digitaria. Principal food crops include maize, phaseolus bean, cassava, sorghum, sweet potatoes, bananas, and other pulses like grams and cowpeas. Cash crops include cotton, sugarcane, and trees. Grade cattle are rare in Siaya, but there are large numbers of Zebu cattle, hair sheep, East African goats, and poultry. The 1979 census indicated a district population of 470,000 (about 185 people/km^2). The Luo is the dominant tribe in Siaya.

The smallholder area of Kenya was stratified into agroecological zones by the Ministry of Finance and Economic Planning. This sampling frame for Kakamega and Siaya districts was used for the random selection of two clusters in each district and 20 farms in each cluster (Sands et al. 1982).

Survey farms in both districts were visited at least once per month by the enumerators who were fluent in the local language. The mean farm size per family was slightly larger in Siaya (1.09 ± 0.89 ha) than Kakamega

(0.89 ± 0.84 ha). Almost all farms are extensively cropped and house between four (Siaya) and six (Kakamega) dependants. Half of Kagamega and Siaya household heads are women. Only 15% of the farmers in Siaya district and 2.5% in Kakamega district owned goats.

In addition to the on-farm sites in Kakamega and Siaya districts, research has been conducted at a station near Maseno on the equator at an altitude of 1500 m. The station houses such facilities as agronomy fields, goat barns, a nutrition laboratory, a microcomputer, and offices.

METHODOLOGIES FOR BIOLOGICAL TRIAL COMPONENTS

Participating Farmer(s) - Project Agreements

Evaluation of interventions is conducted in participating farms in the two clusters. At the same time, experiments and performance monitoring are carried out at the research station. Both feed and goat-production trials are designed to match the bimodal rainfall patterns of western Kenya. The first rain starts in March and ends in July, whereas the second starts in September and ends in February. The second rainy season has fewer, more erratic rains as compared to the first. Planting seasons coincide with the start of the rains.

Farmers were chosen from those who had initially participated in the baseline survey because they had understood the purpose of the studies and were the most willing to participate. However, during the course of on-farm trials (1982-85), some farms dropped out while new ones were added. Those who dropped out did so for a number of reasons including loss of introduced goats, death of respondents, breakup of marriages, or migration to other areas. Each respondent farmer was provided with test goats or part of his land was leased for feed production trials after reaching an agreement between the project and the farmers. Based on DPG availability, 10 farmers were initially provided with goats. In subsequent years, the number of farmers increased to 30 and DPG per household increased to 2 or 3 does with kids and in a few cases there was one buck.

Trials and Testing of the Dual-Purpose Goats (DPG)

Farmers participating in the testing of the DPG were provided initially with a crossbred doe (pregnant or with kid at side). The number of placed does and kids per farm increased in subsequent years depending on the successful participation of each farmer and to facilitate statistical comparison of production variables. Goats become the farmer's property after 1 year of successful participation. Between March 1983 and December 1984, out of 101 DPG placed and produced on-farm, 42 were removed by death, selling, transfer, or rejection by farmers. Transfer of trial goats out of the farms was administered by the project; sale of goats was discouraged during the early years (Stages 1 and 2). Recently, farmers who have multiplied their production above five head were advised to sell extras (especially males) to the project, these were in turn redistributed to other farmers. Each respondent farmer was provided with the following: a milk pail and locally available disinfectant, vaccination of goats (enterotoxemia, tetanus, and foot and mouth), and instructions in DPG management including (a) milking management, (b) boma (night enclosure) construction and hygiene, (c) preventive health care (i.e., drenching), and (d) other feeding and production-handling instructions depending upon the special characteristics of each farm location.

Experiments on farms to monitor DPG (50-75% Toggenberg with East African cross) performance and interaction with other livestock classes involved ear tagging and data collection from local cows, goats, and sheep (e.g., fecal samples for microhistological analysis to study seasonal changes in dietary overlap). Initially, it was expected that farmers would request incentives. However, no such request was made and a very successful cooperation has continued.

The scientist-controlled on-farm feed-consumption studies involved placement of esophageal fistulated goats on farms in the Siaya district. This effort necessitated a different form of agreement and provision of some incentives. The farmer is paid rental for a boma and for housing field technicians during sampling. Also the farmer participates in purchases of local goats needed for the comparative study with the DPGs.

During the second stage of on-farm trials, a DPG buck distribution program was initiated. Terms of placement and ownership differed and the researchers' involvement and visitation frequencies were less. Whereas the doe-kid monitoring is intensive and frequent (i.e., daily and weekly milk production recordings and fortnightly body weight measurements), the monitoring of breeding DPG males to local East African does is kept at a minimal level. The DPG bucks are owned by the project. Distribution is usually in response to requests by interested individuals or groups (e.g., church organizations).

Trials and Testing of Feed Resources

The agreements between the project and the participating farmers include cost and length of leasing test plots, security of the plots, and the use produce from the trials. The number of on-farm plots leased in each cluster depends on the number of experiments planned for that season. Because of variations in the farmers' fields (soil fertility, weed infestations, and slopes), care is taken in the orientation of the plots to minimize the environmental effects on the treatments. Although it is desirable to have large plots and several replications, the limitations of available land in peasant farms in the target areas do not often permit this. Plot sizes of 15 m^2 in rectangular configuration with three replicas are preferred. These trials are repeated over two crop seasons to reflect seasonal variations before the experiments are concluded.

The leased trial plots on the farmer's fields are controlled by the scientist; however, the farmer is responsible for protection from damage by farm animals and crop pilfering. Day-to-day management of the plots is planned by the scientists, including which activities should be done by the farmers and their families and which by the scientists and their assistants. Precision work like planting, data collecting by measurements, and sampling are supervised by the scientists. Simpler field operations like fencing, cultivation, and weeding are usually contracted with the farmer's family for cash payments. This arrangement is very popular with the farmers and it helps to improve relations between the farmer's family and the project. This arrangement has been particularly popular with school-age children who, apart from a cash payment or reward, also enjoy being involved with research scientists and their assistants in conducting experimental work at the village level. The cooperation of farmers in this research work is enlisted after the purpose and the need for such a trial is explained to them.

Apart from receiving improved goats and cash payments for their work on the trial plots, the land is leased by a verbal contract for each growing season of 5 months. A further motivation comes from the agreement with the farmer that after sampling, all the sampled forages and grain are given to his family. Trials in the farmers' fields are often conducted to test whether a particular package works well. Group visits by other farmers and project staff are later arranged during which detailed discussions between farmers and scientists take place, and these have proved very beneficial. Farmers also feel proud and tell their colleagues about their successes. This social attention that the farmers get from their neighbours and relatives serves as an incentive. Our respondent farmers proudly tell us about visitors coming from even far places to see the trial goats. Requests for participating farmers to put their test goats in the local shows are met with enthusiasm. In addition, the respondent farmers are more frequently visited by the veterinarians participating in the SR-CRSP Health Project.

On-Farm Measurements of Animal Performance

Milk production and animal body weight and condition are measured periodically by the project scientists and their assistants. Resident enumerators fluent in the local languages visit the farms at least once a week and fill in a survey form, which provides information on doe and kid records (milk production, kidding rate, rebreeding, birth weight, and animal health) as well as feed menu and purchases. Information about losses due to culling, mortality, etc., are also recorded. Each enumerator is provided with calibrated cups for estimating milk production. The farmers are requested to separate the kids from the does at least 8 hours before the morning and the evening milking periods. The enumerators also record birth data and body weight immediately after birth.

All this information is summarized and reported by the enumerators every Monday during a weekly meeting at Maseno. This meeting is attended by all project scientists. During the weekly visits to the station, the enumerators provide to the computer data-entry technicians the vital statistics for immediate coding and storage into the computer. Recently, each respondent farmer was provided with a book of instructions for twice-daily monitoring of milk production. Farmers were instructed to bottle- or bucket-feed the kids; necessary utensils were provided. Verification of these records is made by comparing data with the weekly measurements provided by the enumerators.

Although Stage 2 of this research activity has witnessed gradual expansion of on-farm trials, the on-station controlled experiments are still difficult to monitor accurately at the farm level. However, research under the relatively controlled environment of Maseno station emphasizes collection of data that may be extrapolated to the farm situation. For example, barn-kept goats (for measuring daily milk production and consumption, metabolic studies, and nursing-management practices) are fed local feed resources similar to those being tested in the farms of Kakamega and Siaya.

On-farm disease monitoring takes place routinely. Incidence of gastrointestinal parasites, Brucellosis screening, Contagious Caprine Pleuropneumonia (CCPP), Caprine Arthritis Encephilitis (CAE), and mastitis are monitored. Clinical case follow-up and autopsies are routinely performed with specimens submitted to laboratory testing. In addition, trials to study the genetic resistance of the DPG compared to the local goat breeds take place under the controlled research environment. Body weight and fecal and vegetation sample collections from the clusters are also recorded every 2 weeks by the scientists and their field assistant. Local sheep, goats, and cattle are also monitored. Vegetation samples are processed for chemical analysis, whereas fecal samples are processed for egg counts and microhistological analysis. Processing includes sun drying before oven drying preparatory to grinding.

The contribution of on-farm, noncropped and off-farm grazing areas to the nutrition of the DPGs is being measured. Locally made fecal collection bags worked well without any need for an adaptation (to the harness) period by the goats. Esophageal fistulae are being used for diet sampling. Fistulation of both DPG and the local goats takes place on the trial farm. A well-trained technician tends to the goats. However, the requirement that fistulated trial goats graze in the same locations utilized by intake goats (bushes, far distance) have resulted in considerable losses (due to fistulation stress, feed poisoning, etc.). This problem is being addressed by introducing new fistulated goats with the assumption that between individual animals variation is not significant.

Farmers' Reactions, Opinions, and Observations

Farmers' reactions, opinions, and observations are recorded during discussions while visiting farms. Field days are also held when groups of farmers visit the research station at Maseno and experimental plots and demonstrations in the clusters. The farmers' reactions are also recorded in questionnaires that are specific to particular experiments. Farmers' views are summarized and incorporated into planned future experiments.

A critical consideration is that research on the farmers' fields should not disrupt their farming system and resource base or interfere with the productivity of their farms. This is particularly important when new interventions that have been tested at the research station are undergoing further trials on the farmers' lands.

One respondent farmer (a retired school teacher) in Siaya district has presented his views during the annual SR-CRSP workshops. The farmer summarized his daily recorded observations and the outcome of his discussions with his colleagues (November 1983 - March 1984).

Results of trials on the farms are recorded by (a) visual field observation and (b) careful measurement and recording. The former is done by both the farmers and the project staff to notice and discuss any visible treatment effects, whereas the latter is done by project staff and is followed by analysis. The field observations together with scientific interpretations (biological and economic) are considered when deciding on the potential practical applications and adoption of the methods under test.

Logistics of On-Farm Research

Logistics (personnel, vehicles, and other requirements) are negotiated for each experiment during the annual planning meeting. Detailed protocols, budgets, and schedules are prepared for each experiment.

Multidisciplinary cooperation of various specializations is emphasized. One experiment, may, therefore, be supervised by the agronomist and also require inputs from the animal nutritionist, the economist, and the sociologist. Collaborating research officers (usually BS or MS level) are provided by the Ministry of Agriculture and Livestock Development (MALD). After one or more years' productive association with the SR-CRSP, collaborating officers are granted an MS or PhD training scholarship. Technicians and other personnel needs are provided by MALD or are directly hired by SR-CRSP, usually on an annual basis. Graduate students have also undertaken specific experiments as partial requirements for their degrees from Kenyan and U.S. universities.

Each resident scientist is assigned a vehicle. The range of project vehicles is wide - from saloons to pick-ups to four-wheel-drives. Any scientist can utilize a suitable car for a particular job. In general, saloon cars are used on good roads, whereas pick-ups and the four-wheel-drives are used for on-farm research. Farms are visited at least every 14 days, but usually every 7 days. Each return trip from the project's headquarters in Maseno is about 150 km. Field trips start at about 800 hours and often continue into the afternoon.

Tractors are used in preparing land at the research station whereas hand or animal drawn implements are used for the same operations in the farmers' fields. Equipment such as field scales, balances, tape measures, drying ovens, etc., are used by the scientists whether the experiment is at the station or at the clusters.

Requirements (detergents, milking pails, calibrated cups, seeds, fertilizers, and fencing material) can be obtained in nearby shops in the clusters. Many farmers cannot afford them at their present levels of income.

DPG (one-half to three-quarters Toggenburg with East African crosses) are produced by the project or obtained from private breeders. Multiplication efforts have been restricted by the scarcity of dairy goats in Kenya. However, the recent lift of regulations limiting the introduction of exotic dairy goats may improve the supply. Currently, efforts by the SR-CRSP are under way to test the application of A.I. methods (Ruvuna, personal communication).

Methods of Data Analysis

Methods of data analysis depend upon the type of data. The project uses an IBM XT[2] microcomputer for coding and updating kid and doe records and for preliminary summary and analysis. Simple and programmable calculators are used widely by the project scientists and technicians. Support from mainframe computers may be sought at times depending on special circumstances and needs.

METHODOLOGIES FOR ECONOMIC EVALUATION

Farm-Management Data Collection

Farm-management data are collected from primary and secondary sources. Primary sources include field survey and case studies of target farmers, local extension officers, businesses, and other relevant respondents as well as technical experiments both at the research station and at the target farms. Secondary sources are places where needed data are already available for extraction. These include farm records and published and unpublished documents, especially from MALD.

---

[2] Mention of proprietary names does not constitute endorsement of the product and is for information only.

For each study a questionnaire designed to enable collection of relevant data in a short time is prepared. Trained enumerators assist with data collection. They are made to understand clearly the purpose of the study, data to be collected, the design of the questionnaire, and how to interpret the questions to the respondent farmers. As much of the required data as possible is extracted from secondary sources on the questionnaire to save time and money. The partly completed questionnaires are then used by the scientists and enumerators to collect data from the respondents in the field. For some studies, 1 day's visit to a respondent farm is adequate, but for others two or three visits per week by enumerators for an extended period of several months or a complete crop year have been used, with less frequent visits by the principal scientists for supervisory purposes. Technical experiments generate technical input-output data that are used for economic evaluations. Most of the collected data are stored in cabinet files or computer diskettes until they are ready for analysis.

Data Analysis

Economic evaluations of technical biological data involve quantification of costs and benefits of various production and management practices conducted by biological on-farm and station trials and identification of the economically most promising practices. Certain common methods for summarizing and analyzing farm-management data have been applied, such as frequency distributions, tabular analysis, and accounting techniques - mainly partial-budgeting and gross-margin analysis. In this paper, partial-budgeting analysis is highlighted as it has been largely used for economic evaluations of biological data generated from the various research components. A partial-budget model is outlined in the following table and is applied for initial economic evaluations. One of the treatments of a biological practice is taken as a control. This control may be taken as the practice as close as possible to the current or most likely production or management practice of target farmers. The rest of the treatments are then evaluated against the control through partial budgeting.

Debits	Credits
A. Additional costs	C. Additional receipts
B. Reduced receipts	D. Reduced costs
Incremental costs	Incremental benefits
Marginal net benefit	B:C ratio or absolute marginal rate of return

Incremental costs are the sum of additional (extra) costs and reduced (foregone) receipts. They are the direct and indirect costs that would be incurred over and above the costs of the control practice. Incremental benefits are the sum of additional (extra) receipts and reduced (saved) costs. They are the direct and indirect benefits that would be generated over and above the benefits of the control practice. Marginal net benefit (or cost if negative) is the difference between incremental benefits and incremental costs. The benefit-cost ratio (BCR) is the ratio of marginal net benefit (or cost) to incremental costs. It is the absolute marginal rate of return (or loss if negative) to incremental costs. BCR is the criterion for ranking and choosing among the several treatments of a trial. The higher the (positive) BCR, the more economically promising the treatment is and vice versa. Negative BCR implies that the control practice is the superior practice economically.

The partial budgeting model used in these analyses is based upon the idea that only a minor (partial) change rather than a major (complete) change in farm operation is contemplated. The analysis is therefore, focused on that minor change in isolation, ignoring the rest of the farm operations. In similar ways, the partial budgeting of biological trials data is considered partial. It analyzes data from individual trials about particular farm practices in isolation. It does not take into account comprehensively the interrelationships that exist between the results of feed resources, nutrition management, health, and breeding projects. Such interrelationships can only be adequately dealt with through whole farm modeling. Complete farmer recommendations cannot, therefore, be generated by partial budgeting. Therefore, input-output coefficients are being compiled for subsequent whole farm (linear programming) modeling that will account for the risk element of farming among the target farmers in addition to their resources and other prevailing constraints.

RESULTS AND DISCUSSION

Dual-Purpose Goat Production Systems

Production Variables

The production variables of on-farm and on-station monitored dual-purpose goats initially measured during Stage 1 (limited scale goat placement) are presented in Table 1 (Brown et al. 1983b and Sidahmed et al. 1984). These variables are being examined under the station-controlled data measurement schedules. Data on milk production and consumption under different milking management systems (Table 2) have been collected using menus based on feeds available on farms. Evaluation continues using udder-harnessed does (while keeping kids with mothers) and improved feeding and health-management packages to obtain data on the optimal potential for the dual-purpose goats.

On-farm monitoring of live body weight changes and kid growth rates in the three clusters continues for the third year (1983-85). Data on weight of kids on farm are presented in Table 3. Other data include changes in body weight of does (dual-purpose and local goats), local ewes, and local cows at 14-day intervals. Microhistological analysis of fecal samples from the four livestock classes have started and results are expected to provide important information on the competitive or complementary use of farm feed resources.

The birth weights of kids born in Masumbi cluster were less ($P < 0.02$) than those of kids born in Hamisi and Kaimosi (2.34 ± 0.05, 2.83 ± 0.16, and 2.94 ± 0.25 - mean ± SE, respectively). However, all kids had similar body weights up to 180 days (Table 3). The mortality rate (from birth to 180 days) was higher

Table 1. Dual-purpose goat production variables.[a]

	On-farm[b]		On-station[c]			
			Group 1		Group 2	
	Range	Mean	Range	Mean	Range	Mean
Milk production per lactation (kg)	62-292	140	15-154	113.0	14-139	65
Days lactating	87-242	145	140-239	227.0	62-244	164
Doe weight after parturition (kg)	25-44	32	25.0-34.5	30.2	24-42	33
Doe weight at end of lactation (kg)	-	-	25.5-33.5	28.2	20-39	29
Daily weight change in 150 days after parturition (g)	-70-23	-21	4--4	-8	-64--12	-24
Kidding date	3/5-4/9	3/28	10/2-10/12	10/10	1/1-3/2	2/9

---

[a] All animals fed local feed resources.

[b] Ten does placed on small farms - western Kenya (Brown et al. 1983b).

[c] Fifteen does and 24 does (Sidahmed et al. 1984 and Sidahmed, unpublished data 1985, respectively).

Table 2. **Performance (preweaning) and milk consumption of DPG kids.**

Item	Kids raised on milk only				Kids raised on milk and forage			
	1[a]	2	3	4	1	2	3	4
Total milk consumed (kg)	63	86	68	43	49	47	43	46
Milk consumed per day (g)	1100	640	370	280	390	550	320	250
Milk consumed per kg LWG	8.1	12.7	15.1	15.3	10.5	8.6	7.0	8.4
Growth rate (g/day)	129	53	40	19.0	70	84	45	30
Age at 10 kg weaning weight (days)	57	154	185	–[b]	90	89	147	183
Mortality (%)	20	0	25	100	20	40	20	17
Number of kids	5	4	4	2	5	5	5	6

Source: Sidahmed (1984), Sidahmed et al. (1984).

[a] Treatment: (1) hand milking twice per day (morning and evening), all kids bottle fed to satisfaction; (2) hand milking once per day (morning), kids bottle-fed the exact amount produced by the mother in the morning and suckled the evening meals; (3) hand milking one-half (udder) and letting kid nurse the other half in the morning, reverse teats in the evening; and (4) hand milking - half way (to simulate what is actually done by household members) followed by nursing kids immediately morning and evening).

[b] Both died before weaning.

Table 3. Weight of kids on-farm.

Age (days)	Masumbi		Hamisi		Kaimosi		Placed*	
	No. of kids	Body weight	No. of kids	Body weight	No. of kids	Body weight	No. of kids	Body weight
Birth	13	2.34^{a}	20	2.83^{b}	12	2.94^{b}	16	2.50^{b}
30	12	5.65^{a}	20	6.19^{a}	12	6.36^{a}	15	5.20^{a}
90	11	10.20^{a}	20	9.38^{a}	12	10.55^{a}	13	9.70^{a}
180	10	13.60^{a}	19	16.11^{a}	12	14.20^{a}	12	13.00^{a}
270	9	19.90^{a}	19	18.90^{a}	12	25.50^{b}	8	15.70^{c}
% surviving birth to 180 days	70		95		100		75	

Source: Sidahmed (unpublished data, 1985).

* Kids introduced to the trial farms from Maseno research station.

abc Not having the same superscripts in each row means they are significantly different ($P < 0.02$ - < 0.05).

among kids born in Masumbi (30%) and kids placed in the three clusters from Maseno research station (25%) than among kids born in Hamisi and Kaimosi (Table 3). This high survival rate among kids born in Kakamega district should be considered when new DPG placements are considered. Pregnant or dry does should be placed rather than mothers with followers.

Based on earlier research results, we have recommended weaning at 10 kg of body weight (Brown and Nderito 1983). Therefore, if this recommendation is accepted by the farmers, we should expect kids to be nursed up to the age of 100 days. This will provide farmers with 100 days of shared doe milk and only 50 days when all milk produced will be used by the household members, assuming the doe is dried 5 months after kidding.

On-Farm Evaluation of Natural Feed Resources

The characterization phase of Kakamega and Siaya smallholder farming systems has emphasized the importance of unimproved lands as principal sources of ruminant feeds (Sands et al. 1982). Typically, animals spend most of the daytime tethered or herded on unimproved lands, along road sides, and in harvest fields. The contribution of these resources to the diets of dual-purpose and local goats was investigated. Both breeds of goats consumed submaintenance levels between 21 June and 25 October 1984. Although both breeds had similar body weights, the amount consumed by the DPG was significantly ($P < 0.05$) larger (1.79 ± 0.13 SE versus 1.36 ± 0.15 SE, respectively). Both breeds selected diets higher in crude protein and neutral detergent residue (NDR) than vegetation on-offer ($P < 0.05$). However, in vitro dry matter digestibility values were similar and below levels required by ruminants to attain maximum genetic capacity for performance in weight gain or milk yield (McDowell 1972).

Using fistulated animals in remote farm trials necessitated collection of extrusa (diet) and fecal samples from goats other than those used during the initial sampling periods. Some fistulated animals died or were culled due to poor body condition. The experience of the respondent farmers regarding foraging behaviour of goats was considered when diet sampling protocols were scheduled. It was observed by farmers in western Kenya, and lately by the SR-CRSP staff, that active morning grazing starts at 1100 hours and not at 800 hours - the time when goats were released out of the night enclosures (bomas). Probably high, ground-level humidity during the early morning hours discourages foraging, particularly grazing, by goats.

Information on utilization and quality of target feed resources was obtained from on-station metabolic studies. Local feedstuffs consumed by DPGs during early to late pregnancy (Brown et al. 1984b; Sidahmed 1984) did not reflect what was offered in quality and quantity. By exhibiting a very selective behaviour, the goats consumed only small quantities of some feeds (i.e., Sesbania, pigeon pea, and napier grass), although the digestible energy of what was consumed was high. These subrequirement consumption rates resulted in poor performance (abortion, loss in body weight, etc.). The discrepancy between the value of feeds offered and the consumed portion was greater in tropical legumes with major differences between parts (i.e., leaves versus stems). Therefore, introduction of leguminous plants rather than grasses as interventions to DPG production systems should be done with care.

Research priorities for the near future are to measure, with more precision, changes in consumption and animals' response when a larger variety of feeds is offered to goats. Also, plans are to measure the optional production variable of the DPGs under minimum health and nutritional constraints.

Animal Health

One of the significant findings reported in the animal health survey (Abinanti et al. 1982) was the prevalence of nematods in the local sheep and goats. In Siaya district, the prevalence rate was 84%, whereas in Kakamega it was 79%. Moderate infection (500 eggs/g) was 36% and 51% in Siaya and Kakamega, respectively. Further work (Shavulimo et al. 1984) indicated that Haemonchus was not only the most predominant nematod, but it was prevalent year round. Its potential for clinical disease and economic importance was recognized. Haemonchus contortus is regarded as the most important helminth parasite economically in the tropics and subtropics (Preston and Allonby 1979). Due to limited land resources (Sand et al. 1982) intensive husbandry practices on farms result in intense pasture and pen contamination with parasite eggs by carrier animals. Station-reared goats exhibited more of both infectious and noninfectious diseases. This was apparently due to the crowded barn and pasture environment at the research station. On the farm, goats are kept in relatively fewer numbers and get more individual care by the farmers. Generally, the highest rates of mortality were caused by mineral deficiency (2.9%), pneumonia (7.2%), and plant poisoning (2.2%).

A station-controlled study of resistance to haemonchosis was designed to evaluate the susceptibility of East African, Galla, and DPGs to the parasite _H. contortus_ worm egg counts in the feces (EPG), packed cell volume (PCV) (a measure of anaemia), total serum protein (TSP), body weight, and mortality rates of the different breeds when infected or not. Initial analysis showed no significant differences between the three infected goat breeds in EPG, PCV, TSP, or body weight. However, mortality rates among infected Galla goats were the highest (67%). Survival among the local East African goats was highest. The influence of worm infestation as indicated by the number of eggs per gram (EPG) on PCV was not significant in these breeds, although the correlation coefficient of the simple linear regression (PCV = f (EPG)) was highest in data collected from East African and DPGs (r = -0.42 and -0.39, respectively) and lowest in the data collected from the Galla breed (r = -0.11).

Feed Resource Component

Nutritive Value of Natural and Cultivated Forages

Farmers practice cut-and-carry of forages to supplement tethering or a combination of tethering and grazing practices. The use of uncultivated plant species constitutes approximately 60% of the total biomass fed to the livestock, while the rest comes from cultivated ones. It is interesting that both natural grasses and common weeds have high contents of crude protein (CP) (17.0 and 23.6%, respectively). The level of CP in common weeds is similar to that of cultivated forage legumes. It should, however, be noted that some of the high protein levels in common weeds may not readily be available to support high livestock productivity. The nutrition and management component of the SR-CRSP project in Kenya is examining these forages to establish their feed values. The cultivated forage legumes have been selected and evaluated for their nutritional qualities. Because these forage legumes have such high CP levels and grow readily in western Kenya, their potential as sources of high protein feeds is very promising. Forage legumes can also provide human food (e.g., Cajanus cajan), soil nitrogen fixation, fences, and shade (e.g., Leucaena, Sesbania, and Gliricidia species).

Intercropping Feed/Food Crops

Because of high land pressure in the study areas, most of the land is planted under food crops, thereby leaving little fallow land for communal or family grazing needs. It has, therefore, become necessary to develop experiments in which food and forage crops are intercropped. In such crop combinations, the forage crop should not significantly reduce the yields of the associated food crops. Maize is the main food crop in these areas and, therefore, several potential forage crops have been tested with it. Tested forage crops were legumes (pigeon pea, Sesbania) and Sudan grass. These crop combinations were grown with or without NPK (20-20-0) fertilizer at the rate of 40 kg/ha of NP_2O_5. Although this trial was conducted at three sites, data from only one site (Kaimosi) will be presented here to show the interaction of combinations.

There were no significant differences ($P < 0.05$) in maize grain yields between the various treatments in nonfertilized plots, except between maize/Sudan grass, maize/Sesbania, and maize/pigeon pea. In the fertilized plots, maize/pigeon pea intercrop significantly ($P < 0.05$) out-yielded both pure maize and maize/Sesbania intercrop. There were no significant differences between other crop combinations.

In the nonfertilized plots, the maize/Sudan grass intercrop performed significantly ($P < 0.05$) poorer than both the maize/Sesbania and maize/pigeon pea combinations. The nonfertilized maize/pigeon pea plot gave the second highest grain yield (2.34 mt/ha cf. 2.47 mt/ha in maize/Sesbania). It should, however, be noted that, although nonsignificantly different ($P > 0.05$), pure maize yields ranked third in both fertilized and nonfertilized plots. Considering both fertilized and nonfertilized plots, intercropped plots yielded more grain than pure maize plots by 0.35 mt/ha (18.92%). Data on the effect of fertilizer on forage dry matter yields in Kaimosi show that fertilizer increased forage dry matter yields by 6.9 mt/ha (57.31%). Intercropping increased forage dry matter yields by large margins, 11.95 mt/ha (174.45%) and 18.27 mt/ha (166.09%) in nonfertilized and fertilized plots, respectively.

Several food crops also have a potential for producing animal feeds. In our experiment we have observed the following forage yields over several locations and seasons: maize 18, pigeon pea 4, sweet potato 5, and finger millet 4 mt DM/ha per 4 months, respectively. It would, therefore, seem that in western Kenya, fallow grazing lands can be efficiently replaced by forages derived from the cut-and-carry of weeds and planted forage crops, intercropping food crops with forage crops, and utilizing forage parts of food crops.

On-Farm Feed Storage

Efforts for efficient on-farm silage making were not successful (Brown et al. 1983a). Therefore, a hay-bailing technique using wooden boxes was tried. If successful this intervention will permit farmers to store surplus feeds for use during the dry season. The feasibility and cost of the hay-making boxes are currently being evaluated by the project scientists.

Economic Evaluation

The economic analysis of the performance of DPG kids under different preweaning feeding practices (Table 2) has been performed (Mukhebi and Sidahmed 1985). The analysis quantifies economic costs and benefits of the following preweaning kid milk-feeding practices (Table 4) with and without forage supplementation: feeding milk ad libitum, feeding mother's milk only; feeding half mother's milk (half udder); and feeding about half mother's milk. The analysis also assesses the impact of forage supplementation (Table 5) and identifies the most promising economic feeding practices. The major results of economic analysis were (a) feeding kids milk ad libitum is economically inferior to the rest of the practices considered, with or without forage supplementation; (b) when a forage supplement

Table 4. Economics of kid milk-feeding practices with and without forage from birth to weaning, Maseno Research Station, 1984 (in Kenyan shillings (KES) per weaned kid).[a]

	Feeding milk only			Feeding milk plus forage		
	Total gain[b]	Total loss[b]	Net gain (+) loss (-)	Total gain	Total loss	Net gain (+) loss (-)
Feeding milk ad libitum			Control			
Feeding mother's milk only	328.77	108.03	+220.74 (2.0)[c]	56.57	43.47	+ 13.1 (0.3)
Feeding half mother's milk	400.10	170.43	+229.67 (1.3)	244.42	90.96	+153.46 (1.7)
Feeding about half mother's milk	-	-	-	334.22	131.30	+202.92 (1.5)
Mean gain or loss	364.44	139.23	+225.21 (1.6)	211.74	88.58	+123.16 (1.4)

[a] 1 US$ = 16 KES.

[b] Incremental benefit (gain) or cost (loss) as compared to feeding milk ad libitum used as control.

[c] Figures in parentheses are benefit:cost ratios (BCR) computed as a ratio of net gain (+) or loss (-) to total loss. BCR is an absolute marginal rate of return on incremental costs. When multiplied by 100, it yields a percentage return.

Table 5. Economics of feeding kids from birth to weaning with milk plus forages as compared to milk only without forage, Maseno Research Station, 1984 (in Kenyan Shillings (KES) per weaned kid).[a]

Feeding practice	Feeding kids with milk plus forage		
	Total gain[b]	Total loss[b]	Net gain (+) loss (-)
Feeding milk ad libitum	180.44	256.90	-76.46 (-0.3)[c]
Feeding mother's milk only	34.24	228.07	-193.83 (-0.8)
Feeding half mother's milk	61.26	43.47	+17.79 (0.4)
Feeding about half mother's milk	-	-	-
Mean gain or loss	91.98	176.15	-84.17 (-0.5)

[a] 1 US$ = 16 KES.

[b] Incremental benefit (gain) or cost (loss) as compared to the same feeding practice without forage.

[c] Figures in parentheses are benefit:cost ratios (BCR) computed as a ratio of net gain (+) or loss (-) to total loss. BCR is an absolute marginal rate of return to incremental costs. When multiplied by 100, it yields a percentage return.

is not provided the practice of feeding the kids mother's milk only is the most promising economically, followed by feeding half mother's milk; (c) when a forage supplement is provided, feeding half of mother's milk is economically the most promising practice, and (d) overall, it is uneconomical to supplement milk with forage in preweaning kid feeding practices, except when the practice of feeding half mother's milk is adopted.

Another economic analysis (Mukhebi and Onim 1985) had the objectives to quantify economic costs and benefits of intercropping selected forage crops (Sudan grass, Sesbania, and pigeon peas) with maize, the staple crop, assess the economic impact of applying fertilizer to maize in both pure stand and intercropped with the forage crops, and identify, economically, the most promising maize-forage intercrops for the Kaimosi cluster-type of farming systems.

The major findings were (a) intercropping forage crops with maize yields greater economic returns, as much as 4100 KES/ha (1 US$ = 16 Kenyan shillings (KES)), than pure stand maize, with or without fertilizer application; (b) applying fertilizer to maize in pure stand or intercropped with forage crops yields greater economic returns (as much as 6600 KES/ha) than the same crops unfertilized; (c) when fertilizer is not applied, the maize-pigeon pea and maize-Sesbania intercrops fertilizer, in that order, are the economically most promising maize-forage intercrops; (d) when fertilizer is applied, maize-Sudan grass and maize-pigeon pea intercrop, in that order, are the most promising intercrops.

The economics of internal parasite control among goats has been assessed (Mukhebi et al. 1985). The analysis quantifies economic costs and benefits of controlling *H. contortus* worms among three breeds of goats - East African (EA), Galla, and East African x Toggenburg Cross (EA x T) - and assesses the performance of the three breeds of goats under controlled and uncontrolled worm infestation conditions.

The main findings reveal that: (a) substantial economic benefits are generated from drenching EA (BCR = 3.4), Galla (BCR = 5.5), and EA x T (BCR =

5.8) against internal parasites; (b) EA goats are economically superior to the Galla and EA x T goats under uncontrolled internal parasite conditions; and (c) the EA x T goats are economically superior to the Galla goats both under controlled internal parasite conditions and superior to the EA only under controlled parasite situations.

REFERENCES

Abinanti, F., Sayer, P., Bari, J., Mbwiria, S., Wescot, and Zealand, M. 1982. A survey of goat health and management amongst smallholders in two districts in western Kenya. California, 95616 USA, University of California - Davis, SR-CRSP Technical Report Series.

Boor, K.J., Brown, D.L., and Fitzhugh, H.A. 1984. Consumer acceptance of goat milk products in western Kenya. California 95616 USA, University of California - Davis, SR-CRSP Technical Report Series No. 41.

Brown, D.L., Chavulimu, E., Salim, M.K., and Fitzhugh, H.A. 1983a. Effects of sweet potato vines additions and stover maturity on maize silage quality. In Proceedings of the 2nd SR-CRSP Kenya Workshop, 22 February, Naivasha, Kenya. California 95616 USA, University of California - Davis.

Brown, D.L., Fitzhugh, H.A., Chavulimu, E., Kiguhi, H., Otieno, E., and Amuhinda, P. 1983b. Evaluation of lactating Toggenburg x East African does on small farms in western Kenya: Year 1. In Proceedings of the 2nd SR-CRSP Kenya Workshop, 22 February, Naivasha, Kenya. California 95616 USA, University of California - Davis, pp. 11-16.

Brown, D.L. and Nderito, M. 1983. Performance and milk requirements of Toggenburg x (Toggenburg x East African) kids weaned at two months of age or ten kilograms body weight. In Proceedings of the 2nd SR-CRSP Kenya Workshop, 22 February, Naivasha, Kenya. California 95616 USA, University of California - Davis, pp. 17-19.

Brown, D.L., Chavulimu, E., Fitzhugh, H.A., and Sidahmed, A.E. 1984a. Effect of ensiling or drying on five local forage species in western Kenya. In Proceedings of the 3rd SR-CRSP Kenya Workshop, 5-6 March 1984, Kabete, Nairobi. California 95616 USA, University of California - Davis, pp. 29-36.

Brown, D.L., Salim, M., Chavulimu, E., and Fitzhugh, H.A. 1984b. Intake, selection, apparent digestibility and chemical composition of Napier grass and pigeon pea foliage as utilized by lactating goats in western Kenya. Paper submitted to Journal of Tropical Animal Production.

Campbell, Rex R., Suda, C.A., and Lionberger, H.L. 1984. A social systems description of small farmers in two western Kenya districts. California 95616 USA, University of California - Davis, SR-CRSP Technical

.C., Hart, R., Blackburn, H., Ruvuna, F., Tallam, S., and Howard, P. 1984. Results of systems analysis application to dual purpose goat production in Western and Nyanza provinces. In Proceedings of the 3rd SR-CRSP Kenya Workshop, 5-6 March 1984, Kabete, Nairobi. California 95616 USA, University of California - Davis.

De Boer, A.J., Fitzhugh, H.A., Hart, R.D., Sands, M.W., Job, M.O., and Chema, S. 1984. Production of meat and milk from goats in mixed farming systems in the high potential tropics. In Simpson and Evangelou, ed., Livestock development in subsaharan Africa: constraints prospects and policy. Boulder, Colorado USA, Vestview Press, pp. 335-359.

Fitzhugh, H.A. 1984. Dual purpose goat production systems for small holder agriculturalists. In Blond, R.D., ed., Partners in Research, California 95616 USA, University of California - Davis, SR-CRSP, pp. 101-112.

McDowell, R.E. 1972. Review of animal production research in Iran, AGA: SF/IRAN. Rome, Italy, Food and Agriculture Organization of the United Nations (FAO), Technical Report No. 1.

Mukhebi, A.W., Nyaribo, F.B., Bernsten, R.H., Reynolds, E., and Mbabu, P. 1984. Preliminary socio-economic evaluation of the dual purpose goat enterprise in the small-scale farming systems in western Kenya. Proceedings of 3rd SR-CRSP Kenya Workshop, 5-6 March 1984, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Mukhebi, A.W. and Onim, J.F.M. 1985. Economics of intercropping forage crops with maize in Kaimosi, Kakamega district. In SR-CRSP Kenya Seminars, January 8, Maseno, Kenya. Maseno, Kenya, SR-CRSP, p. 24.

Mukhebi, A.W. and Sidahmed, A.E. 1985. Economics of preweaning kid feeding practices at Maseno Research Station. In SR-CRSP Kenya Seminars, January 8, Maseno, Kenya. Maseno, Kenya, SR-CRSP, p. 21.

Mukhebi, A.W., Shavulimo, and Rurangirwa, F. 1985. Economics of internal parasite control among goats. In SR-CRSP Kenya Seminars, January 8, Maseno, Kenya. Maseno, Kenya, SR-CRSP, p. 22.

Onim, J.F.M., Fitzhugh, H.A., Hart, R., Otieno, K., and Sidahmed, A.E. 1984a. Small ruminant-CRSP goat project: its organization and feed-production, workshop on small ruminant production systems in the humid zone of West Africa, 23-26 January, Ibadan, Nigeria. Ibadan, Nigeria, International Institute of Tropical Agriculture (IITA).

Onim, M., Hart, R., Otieno, K., and Fitzhugh, H.A. 1984b. Potential of intercropping forage crops with maize in western Kenya. Proceedings of 3rd SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Preston, J.M. and Allonby, E.W. 1979. The influence of breed on the susceptibility of sheep to Haemonchus contortus infection in Kenya. Research in Veterinary Science, 26, 134-139.

Reynolds, J.E., Mbabu, A.N., and Dolan, M. 1984. Extension services and the small holder. A report of preliminary findings. In Proceedings of 3rd SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Rurangirwa, F.R., McGuire, T.C., Kibor, A., Bari, J., and Wambugu, A. 1984. Preliminary studies on induction of protection immunity in goats against CCPP by freeze dried F-38 antigens. In Proceedings of 3rd SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Ruvuna, R., Cartwright, T.C., Smith, G.M., Bradford, G.E., Berger, Y.M., Ahuya, C., and Muia, J. 1983. Preliminary results of performance of different breeds of goats at Ol'Magogo. In Proceedings of 3rd SR-CRSP Kenya Workshop, 22 February, Naivasha, Kenya. California 95616 USA, University of California - Davis.

Salim, M., Ochieng, W., Fitzhugh, H.A., and Sidahmed, A.E. 1984. SR-CRSP dual purpose goats in western Kenya: history and record. In Proceedings 3rd SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Sands, M.W., Fitzhugh, H.A., McDowell, R.E., and Chema, S. 1982. Mixed crop-animal systems on small farms in western Kenya. California 95616 USA, University of California - Davis, SR-CRSP Report No. 17.

Shavulimo, R.S., Sidahmed, A.E., Gisemba, F., and Odero, O. 1984. Health problems in goats in western Kenya. In Proceedings of 3rd SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis.

Sidahmed, A.E. 1984. Priorities and methodologies for developing a nutrition and management package for the dual purpose goat production technology in western Kenya. In SR-CRSP Kenya seminars, 28 November, Maseno, Kenya. Maseno, Kenya, SR-CRSP.

Sidahmed, A.E., Khainga, M.S., Fitzhugh, H.A., and Musalia, L. 1984. Performance of dual purpose does and kids under different milking and nursing management systems. In Proceedings of the 3rd annual SR-CRSP Kenya Workshop, 5-6 March, Kabete, Nairobi. California 95616 USA, University of California - Davis, pp. 47-51.

DESIGN AND IMPLEMENTATION OF IN-HERD/ON-RANGE TRIALS: USE OF SENTINEL HERDS

B. Fadlalla and Richard H. Cook

Western Sudan Agricultural Research Project/Kadugli
(WSARP), Agricultural Research Corporation, P.O. Box
5141, Khartoum South, Sudan

Abstract *The establishment of sentinel herds and flocks is one means for overcoming some of the obstacles facing farming-systems researchers addressing the problems of pastoral-production systems. The design and adoption of production-increasing interventions requires attention to both the identification of the major causes of production constraints and an understanding of how producers mobilize their resources to achieve their production objectives. For new technologies to be adopted by producers they must be demonstrated to be superior to existing pastoral practices. The diagnosis, design, and testing of a technology may require extended periods of data collection that involve the handling and sampling of animals. Pastoralists are, however, reluctant or unwilling to permit the manipulation of their animals as this disrupts their daily management routines.*

Sentinel herds and flocks, owned by the research station but similar to traditional groups in composition and management, have provided the Western Sudan Agricultural Research Project (WSARP) with opportunities to (a) initiate diagnostic studies; (b) plan, design, and implement researcher-managed trials; and (c) familiarize pastoralists with research methodology while familiarizing researchers with some of the problems of pastoralists. These interactions between research staff and producers have resulted in the concurrent implementation of applied and adaptive trials with producer animals.

Résumé *L'un des moyens de vaincre certains des obstacles qu'affrontent les spécialistes qui s'attaquent aux problèmes de la production pastorale consiste dans la formation de troupeaux avant-coureurs. La conception et l'adoption d'activités visant à accroître la production exigent que l'on connaisse les obstacles à éliminer et que l'on comprenne comment les producteurs utilisent leurs ressources pour réaliser leurs propres objectifs de production. Pour que les producteurs adoptent de nouvelles technologies, il est nécessaire de démontrer que ces dernières sont supérieures aux pratiques pastorales existantes. Les études diagnostiques et les travaux de conception et de vérification, qui accompagnent toute technologie, nécessitent parfois que l'on consacre de longs moments à la collecte des données, de même qu'à la manipulation et à l'échantillonnage des animaux. Or, les pasteurs hésitent à permettre une telle manipulation ou même s'y refusent, puisque cela dérange l'organisation habituelle de leurs journées de travail.*

Les troupeaux avant-coureurs sont la propriété de la station de recherche, mais par leur composition et par le type de gestion dont ils sont l'objet, ils sont semblables aux troupeaux traditionnels. Ils ont permis au Western Sudan Agricultural Research Project (WSARP) (a) d'entreprendre des études diagnostiques, (b) de planifier, concevoir et mettre en oeuvre des essais dirigés par les chercheurs et (c) de faire découvrir aux pasteurs les méthodes de recherche, et aux chercheurs certains problèmes de la vie pastorale. Fruit d'une telle interaction entre chercheurs et producteurs, c'est la mise en oeuvre en collaboration avec les producteurs, d'essais pratiques et adaptables.

Sudan is the largest country in Africa with a total land area of approximately 2.5 x 10^6 km^2 and a population of more than 20 million. Topographically, the country is a vast plain with only occasional hill and mountain ranges, encompassing a diverse array of ecological zones that roughly follow a north-south gradient. These zones range from desert and sparse scrubland in the North, through arid and semi-arid brushland and wooded savannas, to lush grasslands, woodlands, and closed-canopy forests in the South. It is estimated that the potential livestock utilization of these zones represents 57% of the country, 1.4 x 10^6 km^2, (Bunderson et al. 1984), with 79% of this figure,

i.e., 45% of the country, occupying the drier ecological zones.

Sudan's national herd currently numbers about 53 x 10^6 head, with 19.6 x 10^6 cattle, 18.2 x 10^6 sheep, 13.2 x 10^6 goats, and 2.6 x 10^6 camels (Booker Agriculture International Ltd 1981). In terms of tropical livestock units (TLU), these numbers collectively represent 30.4 x 10^6, accounting for about 17.7% of Africa's ruminant population (Winrock 1981). Cumulative percentages indicate that the north of Sudan is resident to about 75% of all the livestock and 65% of the cattle (Booker Agriculture International Ltd 1981).

Economically, agriculture contributes approximately 40% to the total gross domestic product (GDP) and approximately 95% of total export earnings while providing a livelihood for 80% of the population. Livestock account for roughly one-half of agriculture's contribution to the GDP and a much smaller percentage to export earnings. Total foreign exchange earnings derived from livestock exports amounted to approximately US$39 million in 1979/80, rising to more than US$70 million in 1981/82. Earnings in 1982/83 were about at parity with 1981/82 levels, although cattle exports during the period were only about 50% of the 1981/82 figures as a result of quarantine restrictions imposed by importing countries in response to rinderpest outbreaks in Sudan's cattle-producing areas. Sheep exports, however, rose by more than 22%, off-setting the potential foreign-exchange losses resulting from decreased cattle exports.

The target area for the Western Sudan Agricultural Research Project (WSARP) encompasses the two western regions of Darfur and Kordofan. These regions represent an area of about 850,000 km^2 and contain a population of about 6 x 10^6 (Department of Statistics, Ministry of Finance and Planning 1983). In terms of contribution to national livestock production, these regions contribute an estimated 40% of the cattle, 37% of the sheep, 42% of the goats, and 58% of the camels (Booker Agriculture International Ltd 1981). Within the livestock sector three production systems predominate: transhumant, nomadic, and sedentary. However, the vast majority of livestock are found in the transhumant and nomadic systems, with the former accounting for the majority of the cattle production.

The specific target area for the studies discussed in this paper is the southern part of the Kordofan region. Within this area, the majority of livestock are found in the transhumant system and, based on this factor and the apparent comparative economic advantage transhumant producers have with respect to livestock production, research activities have focused on this production system.

The basic components of the Baggara transhumant system are illustrated in Fig. 1.[1] This system, which is dominated by an extensive livestock component, chiefly cattle, but including sheep and goats, is characterized by a pattern of transhumance involving migrations of varying distances to arid, sandy ranges in the North during the rainy season, returning to specific areas in the clay-dominated ranges of the South during the dry season. Traditional livestock-management practices have developed in response to the need for securing year-round sources of forage and water and escaping the mud and fly problems associated with the southern ranges during the rainy season.

With the start of the rains in May and June, transhumants leave their dry-season camps and move with their cattle to areas that have received the early rains. This movement, which usually involves only men, gives animals access to grazing areas that were previously inaccessible during the dry season because of the absence of water. In addition, the laborious task of hand-drawing drinking water for livestock becomes unnecessary. Animals exploit locally available grazing and water during this time and will only start the northward trek in July after the major rains commence.

The trek northward progresses at a rate of 10-20 km every second or third day, although the

---

[1] Exploratory surveys of the transhumant system were conducted by Dr W. Trent Bunderson, Range Ecologist; Dr Babo Fadlalla, Animal Nutritionist; and Dr Joel Teitelbaum, Anthropologist.

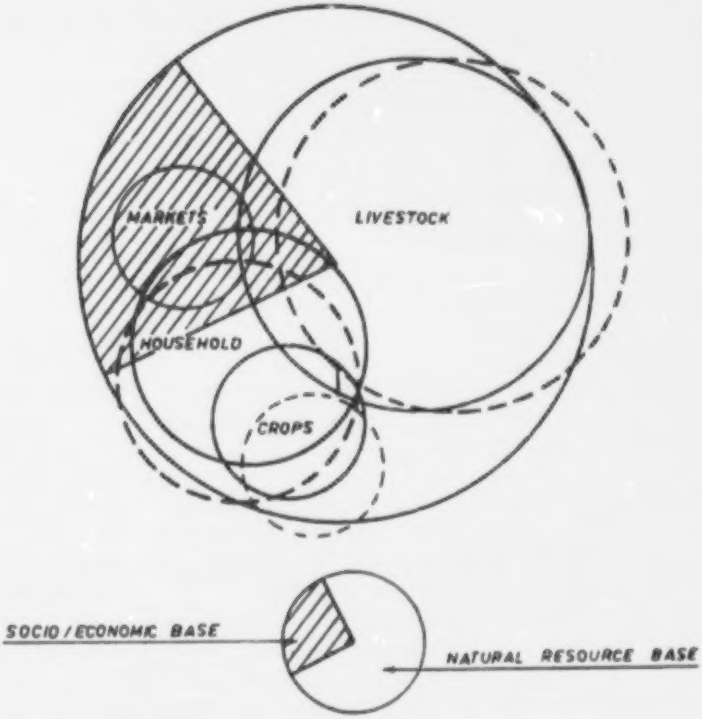

MARKETS
LIVESTOCK
HOUSEHOLD
CROPS
SOCIO/ECONOMIC BASE
NATURAL RESOURCE BASE

Fig. 1. Pastoral production system.

frequency of movement and the daily distances traveled are a function of several factors:

(a) The presence of cultivated fields in the area, which are a source of conflict with sedentary farmers, may force a fariq (group of related families) to avoid an area entirely or extend the daily trek so that livestock intrusion into fields is minimized;

(b) Abundant sources of surface water and forage may extend the period of time spent at intermediate stops along the migration route; and

(c) Additional time may be spent at intermediate stops where a particular migratory group has family ties with a sedentary farming group, and joint efforts at cultivation may be undertaken.

The entire trek lasts for about 1 month during an average rainfall year, whereas the actual total distances traveled vary with the transhumant group and the amount and distribution of rainfall. The time spent grazing the northern ranges varies from 1 to 2 months, depending on the availability of forage and water, with the southern trek generally commencing in mid- to late September. The strategy during the southern trek is to leave the North as early as possible to ensure enough grazing and water en route. In 1984, it was an exceptional year in that the total rainfall was roughly one-half the long-term yearly average for both the northern and southern regions. This forced many transhumant producers to spend the entire rainy season on the southern ranges for the first time in recent history.

By mid-October through November, transhumants begin arriving in the South. During this period full use is made of the grazing around temporary water sources, leaving the forage close to permanent sources of water for use later in the dry season when water supplies become more limiting. This strategy is successful because there are apparently some traditional user-rights to wells based on their continual use year after year. By mid-December or early January, transhumants settle for the remainder of the dry season, unless forced to move because of range fires, which deplete forage resources, or disease outbreaks such as rinderpest or contagious pleuropneumonia. During the dry season, fariqs locate their camps near shallow-dug wells on the footslopes of hills or in dry, ephemeral stream beds (khors). Other groups depend on permanent sources of surface water for their animals. Fariqs remain in these dry-season camps until the onset of the early rains when the cycle begins again.

Livestock productivity in traditional herds is characterized by long parturition intervals, poor neonatal growth, low milk production, and low average yearly weight gains for all classes of livestock. Diseases pose less of a constraint on improving productivity than poor nutrition, although long-term changes in the existing system, which may attempt to exploit the southern ranges more efficiently, will have to deal with several additional disease constraints that now limit their utilization.

Subsistence transhumants characteristically have multiple production objectives with regard to their livestock enterprises. For cattle, intermediate products such as milk and transportation play a dominant role, whereas increasing herd size is viewed as improved security and equity on which to draw for large cash expenditures such as school fees, customary obligations, and pilgrimages. Milk production plays an important and unique role in the total production picture because it represents a commercialization process controlled by the women. Raw milk, as well as several milk products, are sold by women to provide cash for the purchase of market goods. Small ruminants, sheep, and goats, provide meat for household consumption but, more important, are heavily commercialized to provide cash for the purchase of market staples, especially food grains.

Several factors are considered important in the maintenance of transhumance: (a) biting flies, disease, and mud are most frequently cited by producers as the major factors forcing northerly migrations during the rainy season; (b) access to "free" pasture and water across ecological zones provides an escape in the case of drought or disease outbreak; (c) the quality of forage on the sandier, northern ranges is claimed by producers to be superior to that found on the southern clay plains. This claim has been supported by studies conducted in similar ecological areas in Western Africa (Breman and deWit 1983); and (d) other factors that include better access to markets in the North.

The Baggara transhumant system, similar to most pastoral systems, is highly mobile. Advantages of this mobility have already been cited; however, it has several disadvantages, a principal one being the lack of control over management of the natural resources, which precludes the introduction of many range-management practices. In such situations, individuals try to maximize their share of a common resource by keeping large numbers of animals, frequently resulting in rangeland deterioration. In the Kordofan region, this practice is especially critical in the fragile northern areas that are heavily grazed during the growing season with the result that plants are grazed before seed-set, reducing their chances of reestablishment during the following season. The situation is different in the southern areas because grazing pressures occur after the plants have reached maturity and shed their seeds. However, range fires in the South have been reported (Bunderson 1984) to destroy some 30% of the annual forage production during the dry season.

Poor dry-season nutrition is the major constraint limiting cattle production in South Kordofan. It is the result of several factors, including the limited availability of permanent water sources and the resultant depletion of nearby forage reserves and the poor quality of standing hay. Under such conditions, animals have been shown to lose about 28% of their liveweight during the period of January through June, with 71% of this loss occurring in the last month (Fadlalla 1984). Poor nutrition is also complicated by the presence of endemic diseases such as bovine farcy, streptothricosis, and internal/external parasitic infestations. Infrastructural problems, such as the untimely availability of vaccines, drugs, and feed supplements, and the lack of good markets, market information, and roads, further limit management options available to producers to solve major production constraints.

METHODOLOGY

Use of Sentinel Herds in Farming Systems Research (FSR)

During the formulation of our research program, it was realized that neither station research activities nor a strict adherence to farming systems methodology designed for sedentary production systems would be appropriate for a research program focusing on production problems of transhumant production systems in South Kordofan. Off-station research was considered essential to take into consideration both the seasonal/locational variations transhumants experience in the available environmental resources and the socioeconomic factors influencing the allocation of household resources to achieve production objectives. In addition, it was noted that in many cases, research activities focusing on pastoral systems took a relatively long time in which to complete diagnostic surveys, technology design and testing, and producer-managed adoption trials. Therefore, programmatic attempts that were designed to shorten this time-frame were considered highly desirable.

One alternative considered was the immediate use of producer animals to carry out diagnostic studies and then in-herd trials, assuming an appropriate technological intervention had been identified. However, transhumants in our area were reluctant to cooperate with station staff, because these activities necessitated the handling, sampling, and weighing of animals. Moreover, such manipulative procedures had to be conducted over extended periods of time to assess the interrelationships of season, physiological status, and ecological/managerial setting on productivity. Initially, we were faced with a "Catch-22" situation, where researchers were convinced of the necessity to work with producers and their animals to diagnose appropriately the causes of production constraints and identify potential interventions; yet producers had to see and be convinced that these procedures would not have a detrimental impact on their animals before they would even consider cooperating. They also had to gain some appreciation and understanding of the long-term nature of many production-increasing interventions before they would give their continued cooperation throughout the diagnostic and testing phases. Consequently, consideration was then given to establishing sentinel herds to initiate our research program.

Within the context of established farming systems research (FSR) methodology several phases were considered appropriate for utilizing sentinel herds as a research tool, e.g., in diagnostic studies focusing on physical and biological parameters of the production system, implementation of applied research trials, and on adaptive trials. In the case of adaptive trials, sentinel herds were considered to be a good method by which to demonstrate potential interventions to producers under conditions comparable to their own. Although we made every attempt to simulate transhumant conditions, it was not possible to anticipate or account for all the socioeconomic factors that influenced production priorities and resource management in the target system. Accordingly, limited exploratory surveys were undertaken by teams of scientists to examine how traditional households allocated their resources among various production activities and how they prioritized their production objectives.

Considerations for Initiating Sentinel Herd Studies

Two fundamental factors had to be considered if we were to implement sentinel herd studies where we could collect data that were relevant to our target group. First, we had to know some details about transhumant production enterprises, specifically the magnitude of available natural and biological resources and, second, how these resources were managed. Because the predominate enterprise for transhumants in southern Kordofan was cattle production, this species was selected for our initial sentinel herds. Review of secondary sources revealed a scarcity of information relating to cattle productivity in our target system, therefore, we decided that it was necessary to acquire some baseline productivity data from sentinel herd studies. We then had to obtain information on traditional herd size and demographics to compose our sentinel herds.

Such information was collected from livestock surveys, carried out (Bunderson et al. 1984) during the dry season of 1981 and 1982. This season was opportune because livestock were concentrated around permanent sources of water, simplifying the logistics of the survey, and animal purchase was advantageous for the research station because of high seasonal sales and comparatively low prices. In these surveys, animals were counted and their ages assessed using owner "estimates" and dental examinations that were compared to published eruption/wear dates. Table 1 illustrates the composition of a "typical" transhumant herd in our target area.

The next step was the acquisition of the animals. The major source of animals in our area was from the local markets. This exercise required several visits over a period of 2 months during the dry season. The major problem experienced during these purchases was the scarcity of healthy, adult female animals being offered for sale, because transhumants usually sold

Table 1. Composition of a "typical" transhumant cattle herd and the WSARP migratory sentinel herd.

Sex	Age group	Transhumant herd[a]	Sentinel herd
Calves (mixed)	<12 months	16.3	16.4
Females	12-23 months	5.6	4.9
Males	12-23 months	4.1	1.6
Females	2-4 years	10.6	13.1
Males	2-4 years	7.1	9.8
Females	>4 years	43.0	45.9
Females (calved)	>4 years	33.6	36.1
Males (total)	>4 years	13.3	8.2
Castrates	>3 years	5.0	6.6
Average herd size		114	51

[a] Bunderson et al. (1984).

either male or immature female animals. Adult females were sold only when they were old or had some health or reproductive problem, and the latter condition was extremely difficult to assess under market conditions. Thus, the quality of breeding females that were purchased would likely have an important impact on future data collection. The only other option would have been to purchase immature female animals, in which case the collection of productivity data would have been delayed for several years.

Next came the question of how our sentinel herds were to be managed. Our migratory herd was entrusted to a transhumant from our target area. Employed by the research station as a salaried staff member, he took responsibility for maintaining the herd under conditions as close as possible to those prevailing in the area. With his considerable knowledge and experience in migrations between southern and northern Kordofan, he was given virtually total authority for deciding routes and the timing of movements. He and his family migrated with the herd, accompanied by a research assistant who was responsible for data collection. Two oxen were provided for the manager's household to provide transport during migration and a donkey was provided for the research assistant. Seasonal grazing practices were similar to those adopted by our target group. Milking was done once or twice a day, depending on the season, with one front and rear quarter being milked out, the others being left for the calf to suckle. Once the quantity of milk removed was measured, it was given to the manager's household. However, it was stipulated that all milking was to be done by the men, a chore often traditionally done by the women. The intent was to minimize the possibilities of excessive milk being taken from the dam, thus depriving the calf, for sale to local cheese factories or in towns and villages along the migration route, which is traditionally the women's responsibility.

Preventive herd health measures involved vaccinations against diseases common to the area and the vaccines were also locally available to the producers' herds. The collection of research data was done by the research assistant and included adult weights, initially on a monthly basis; calf weights, on a monthly basis; and milk production, on a daily basis. Research station staff made frequent visits to the herd and assisted in data collection, including, in addition to that cited above, seasonal blood and fecal samples.

Merits of Sentinel Herds as a Research Tool

We have found that our migratory sentinel herd has played an important part in our research program by providing us with an opportunity to

(a) Commence immediate and continuous collection of baseline productivity data on a wide range of parameters and to identify some seasonally critical constraints to cattle productivity;

(b) Initiate several applied research trials such as the testing of impregnated ear tags to control flies and external parasites and strategic treatment regimes of antihelmentics to control internal parasites;

(c) Commence applied nutrition studies on voluntary intake and seasonal diet quality to examine critically seasonal nutritional deficiencies;

(d) Collect data and monitor animals on a continuous basis. Because of annual variations in rainfall and, therefore, available forage and water, long-term baseline production data have been important in helping to define and prioritize future applied research activities focusing on anticipated future problems within the target system. Such data have been helpful in providing regional planners and policymakers with information on which to evaluate long-term trends in animal productivity and resource management. For example, we have found that some data generated from our sedentary sentinel herd have provided some insights into solving potentially important health constraints that transhumants will likely face if they attempt extended seasonal utilization of the southern clay plains; and

(e) Improve our contact with producers and facilitate discussions with them concerning their production problems and constraints and demonstrating to them our experimental methodology. The migratory sentinel herd has proven to be a good vehicle for education. Over a 2-year period producers have become convinced that our handling and sampling techniques did not have a detrimental impact on our animals, and, in fact, our sentinel herd was considered "above average" in terms of general condition by producers after only 2 years. This, despite the fact that we likely started with inferior animals when compared to the average producer herd. As contacts grew and confidence was established between research station staff and producers, requests began coming from producers to initiate studies in their own herds and flocks.

Data generated from some of our initial studies with the migratory sentinel herd focused our attention on several potential areas for adaptive research trials. One such trial, involving protein/phosphorus supplementation during the latter stages of the dry season was initiated in 1984 with 100 producer animals.

Confidence generated during the initial stages of this trial encouraged producers to discuss potential trials, and we have recently implemented an adaptive trial with 200 producer sheep looking at salt/phosphorus supplementation during the peak lambing/lactation season.

During our initial activities, where much of our work entailed sampling of animals, the research station assisted producers in acquiring vaccines for their animals. Once a contract was signed to initiate an experimental trial, the station also agreed to provide limited health care for animals on experiment, but only if animals were examined and samples taken for laboratory analysis. Simply giving drugs to producers to treat their own animals has not been encouraged. Several trials were also undertaken with producers to test the efficacy of several locally available antihelmentics and acaricides. These drugs were payed for by producers, administered according to the recommendations of scientists, and then evaluated by both the producer and scientist as to their cost, effectiveness, ease of administration, and availability. Further treatments were left for the producers to implement.

Shortcomings of Sentinel Herds in Farming Systems Research Programs

Sentinel herds are only an approximation of the traditional system. They are, however, a closer approximation than can be achieved under research station conditions, but they do have important limitations. Because of their size, prescribed management options, limited ecological diversity (a problem in any research program where sampling size is restricted), and limited market interactions to provide incentives for marketing animals, sentinel herds cannot be expected to represent the spectrum of differences found within a recommendation domain.

Given the limitations posed by their composition and management, such herds will not identify many of the complexities associated with household decision-making. Because of the diversity in the type of products produced, their uses, their benefactors, and their multifaceted contribution to household security and cultural obligations, livestock productivity is extremely difficult to quantify and prioritize for subsistence pastoralists. In general, these factors can only be understood through continual contact with producers, gaining their respect and confidence.

Long-Term Role for Sentinel Herds in Farming Systems Research Programs

In the final analysis, the success of interventions will be determined by their adoption by target group members through implementation of producer-managed, in-herd trials. This final phase of the research program follows several design and testing phases all of which may or may not have been undertaken for each technological intervention. However, within this farming-systems research framework we feel that sentinel herds can play an important, dynamic role in programs focusing on pastoral production systems. Figure 2 is a graphic illustration of how sentinel herds have contributed to WSARP's transhumant farming system research effort compared with that of producer herds. Sentinel herd contribution has been concentrated in the earlier phases of our research program, specifically in diagnostic or technology identification studies and applied research trials. In part, the focus of sentinel herd activities illustrated in Fig. 2 reflects the present stage of WSARP's activities. As the research program continues, the role of sentinel herds will likely change, responding to program priorities. In our experience, sentinel herds are well adapted for undertaking applied research trials. In our program, depending on the nature of the technology being tested, trials may be initially implemented in the sentinel herd before producer herds, but in other cases applied/adaptive trials may be taken directly to producer herds. In the latter case, it has been our experience that, initially at least, such trials should be conducted under researchermanaged conditions.

There is a continuing need for applied research activities in pastoral farming-systems research programs. If such programs are going to assist in the evolution of pastoral systems they must address critical, current problems as well as attempt to anticipate future constraints the system is likely to face. In this context, sentinel herds provide an important research tool for examining both present and future production problems. In addition, they provide for a continuity

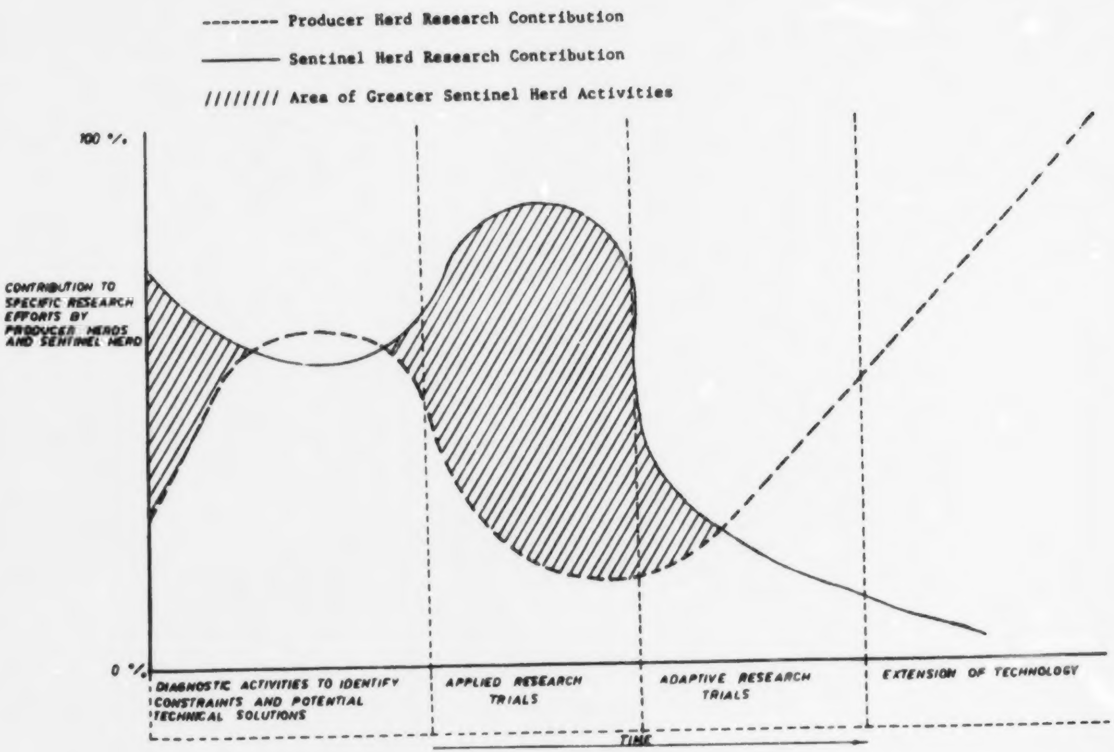


Fig. 2. Initial role of sentinel herd in a transhumant farming-systems research program.

of field activity that reinforces producer contact and builds producer confidence. Such herds provide a mobile laboratory where all results are open for producer scrutiny and where even the most diehard research station-oriented scientist has to experience and cope with some of the practical problems faced by his clients. In our experience, sentinel herds have provided research station staff with as much opportunity to learn as the producer.

CONCLUSIONS

The incorporation of sentinel herds and flocks into farming-systems programs that are addressing production problems associated with pastoral production systems can provide a vehicle for "quickly" implementing limited diagnostic, applied, and adaptive research activities. Such herds and flocks can reduce the time frame and some of the logistical problems commonly associated with conducting field research in pastoral environments. At the same time these animals can serve as an important demonstration and educational tool. The maintenance of sentinel herds also requires a continual field presence, which encourages research station staff to spend more time in the field. Sentinel herds can provide a good "first approximation" to producer conditions for the implementation of applied and adaptive research studies without requiring excessive producer risk or the potential compromise of good scientist/producer relations. To a considerable extent, sentinel herds can replace research station experimental animals, avoiding some of the problems associated with the transfer of technology from controlled research station conditions to the highly dynamic and uncontrollable environmental conditions of the pastoralist.

Within the context of agricultural research in developing countries, whose resources for research are generally very limited, a research mode involving the use of sentinel herds, rather than the necessity of having elaborate research station facilities, is attractive. Such a program does not excessively compete for scarce research resources with established research programs, and it offers a complementary, noncompetitive research approach with the likely already established, discipline, commodity-oriented programs. Such a farming-systems program can help in fostering a vision of research complementarity on the part of professional agricultural researchers in developing countries, a critical first step in the institutionalization of farming systems philosophy within national agricultural research programs.

Sentinel herds cannot substitute for producer herds. The reliability of data generated from sentinel herds and their applicability across a recommendation domain is dependent on how well researchers understand their target system, its natural, biological, and socioeconomic resource base, and how closely these factors can be duplicated and traditionally managed under conditions that are not truly traditional. Sentinel herds and flocks provide, at best, only an approximation of the traditional system because they obviate many of the socioeconomic relationships that traditionally exist between pastoralists and their animals.

Acknowledgments

We wish to acknowledge the financial support given to the Western Sudan Agricultural Project (WSARP) by the Government of the Sudan, the United States Agency for International Development, and the World Bank.

REFERENCES

Booker Agriculture International Limited and the Center for Tropical Veterinary Medicine, Edinburgh, 1981. Statistics. Sudan, Regional Animal Disease Control Project, volume 4, pp. 8, 12.

Breman, H. and deWit, C.T. 1983. Rangeland productivity in the Sahel. Science, 221 (4618), 1341-1347.

Bunderson, W.T., Cook, R.H., and Fadlalla, B. 1984. Range/livestock research activities. Khartoum, Sudan, WSARP, Publication No. 29, 60 p.

Department of Statistics, Ministry of Finance and Planning 1983. Population census, 1983. Khartoum, Sudan, Ministry of Finance.

Fadlalla, B. 1984. Cattle production among transhumant Baggara tribes in Kordofan Region, Western Sudan. Symposium on systems of ruminant livestock production in the Arab countries. Riad, Saudi Arabia, Arab Organization for Agricultural Development, 11-14 November. (In press) (In Arabic)

Winrock International 1981. Livestock program priorities and strategy. Morrilton, Arkansas, USA, United States Agency for International Development.

ON-FARM TRIALS OF MINERAL SUPPLEMENTATION FOR SMALL RUMINANTS IN WEST JAVA, INDONESIA

J.E. van Eys,[1,2] S. Sitorus S.,[1] I.W. Mathius,[1]
and W.L. Johnson[3]

[1]Research Institute for Animal Production, Small
Ruminant-Collaborative Research Support Program
(SR-CRSP), P.O. Box 210, Bogor, Indonesia, [2]at
present with North Carolina State University, and
[3]North Carolina State University, P.O. Box 7621,
Raleigh, North Carolina 27695 USA

Abstract *On-farm supplementation of sheep and goat diets with minerals and urea was carried out in two villages in Java, Indonesia. The supervisory and recording system developed during a previous 2-year diagnostic phase was used in the supplementation trials. Day-to-day control of the trials was in the hands of a two-man village team stationed permanently in the villages. Five treatments varying in mineral and urea concentration were applied to animals belonging to 25 farmers in each village. Each farm received only one treatment. Supplementation was in the form of molasses-rice bran blocks, which were provided free of charge to the farmers.*

Farm means of pre- and postweaning weight gain were used to measure the effect of supplementation. In both locations, mineral provision increased ($P < 0.05$) weight gain of pre- and postweaning young and tended to decrease mortality. Urea had no effect. Postweaning gain based on five animals per farm was a better measure of the effect of mineral supplementation than preweaning gain. For the 9-month duration of the study, six farms per treatment and location were sufficient to detect treatment differences of 20% in postweaning gain ($P = 0.05$). Detection of smaller differences between treatments would require an unrealistically large number of farms.

Résumé *Les essais ont consisté à administrer à des moutons et à des chèvres de deux villages de l'île de Java des rations additionnées de minéraux et d'urée. La méthode d'observation et de collecte de données employée a été celle mise au point lors de la phase précédente de diagnostic, qui a duré deux ans. Le contrôle quotidien des essais était sous la responsabilité d'une équipe de deux personnes par village, équipe demeurant en permanence dans le village. On a administré aux animaux de 25 agriculteurs par village 5 traitements de différentes concentrations de minéraux et d'urée, à raison d'un seul traitement par exploitation. Les suppléments de minéraux et d'urée étaient présentés sous la forme de blocs de son de riz et dc mélasse, distribués gratuitement aux agriculteurs.*

Pour mesurer les effets des suppléments sur le poids, on a employé les méthodes d'évaluation des exploitants pour les périodes d'avant et d'après le sevrage. Dans les deux villages, les minéraux en supplément ont augmenté (P <0,05) le poids des jeunes bêtes avant et après leur sevrage, et semblent aussi avoir diminué la mortalité. L'urée n'a eu aucun effet. Le calcul du gain de poids après le sevrage chez 5 animaux par exploitation, a fourni une meilleure mesure de l'effet des suppléments que le gain du poids avant le sevrage. Au cours des 9 mois de l'étude, il a suffi de 6 exploitations par traitement et par village pour découvrir des différences entre les traitements de l'ordre de 20% dans le gain de poids après le sevrage (P = 0,05). Pour découvrir des différences plus fines entre les traitements, il faudrait un échantillon d'exploitation tellement plus grand qu'il serait irréalisable.

Agriculture in Java, Indonesia, is characterized by small but intensively operated farms predominantly geared toward rice and cash-crop production. Livestock, in particular sheep and goat production, is of secondary importance, but can contribute significantly to total farm output (Knipscheer and Soedjana 1983). Because of the specific role of small ruminants in the existing farm system, farmers generally manage them as a minimum-input activity. Consequently, relative to its output potential, actual small-ruminant productivity is low, and substantial improvements could be made if basic principles of good management and nutrition could

be applied (van Eys et al. 1984). However, the nature of the small-ruminant production system and the farmers' perception of its importance limit, at least initially, the extent to which improvements can be made. To be successful, new and improved techniques of small-ruminant production must be compatible with the existing methods and should continue to have a low-input character.

Extensive survey and monitoring studies have identified diet quality as a major limiting factor in the low performance of sheep and goats under village conditions. Diets for animals under grazing, as well as full confinement, consist mainly of low quality, fibrous grasses and crop by-products (van Eys et al. 1983). Shrub and tree leaves of superior quality are provided infrequently and in a random fashion. A major beneficial aspect of the feeding of shrub and tree leaves is associated with their superior mineral composition. Studies on the mineral content of sheep and goat diets have indicated that substantial fractions of these diets are deficient in phosphorus (P), sodium (Na), copper (Cu), and zinc (Zn) (Panggabean et al. 1982; Prabowo et al. 1983). Mineral concentrations of hepatic tissue from sheep pointed toward deficient concentrations of manganese (Mn) and Zn, and mineral supplementation under experiment station conditions improved both intake and weight gain (Prabowo et al. 1983). Under the existing conditions of marginal and deficient protein and mineral nutrition, on-farm productivity of small ruminants could substantially be increased if farmers would consistently supplement small ruminant diets with minerals and possibly nitrogen.

This paper describes the methodology and results of trials on supplementation of different types of minerals and urea to small ruminant flocks in West Java.

MATERIALS AND METHODS

Site and Farm Selection

The study reported in this paper represents the third phase in a sequence of village research activities that closely followed the pattern suggested by Norman (1978). The descriptive or diagnostic phase that preceded this study started in 1980 and consisted of (a) an extensive baseline survey and (b) a longer term (2 year) intensive monitoring of selected farms. Site and farm selection for the on-farm trials dates back to the initial stages of the descriptive phase. Before the baseline survey, two sites were selected as representative of the area in terms of agricultural activities, animal management, mean animal population density, willingness of village leaders and officials to cooperate, and ease of access. These criteria are largely subjective but allow sufficient flexibility to guarantee institutional cooperation, an absolute requirement for village research (Thomas et al. 1982).

Table 1 shows general characteristics of the two villages and their small ruminant populations. The two villages represent distinctly different ecozones with their specific agroeconomic structure. They can be considered representative for a large area in Java for which improved small ruminant production technology is intended. In the remainder of this paper they will be referred to as the upland site Garut (GAR) and the lowland site Cirebon (CIR).

In the baseline survey, 245 farmers were selected using a proportional, stratified, random-sampling technique with land ownership as main strata and animal ownership as substrata. Results of the baseline survey have been published by Sabrani et al. (1982). The baseline survey allowed further selection of 30 farmers per location to participate in the monitoring program. In GAR, farmers keep only sheep, but in CIR farmers raise both sheep and goats. The two species are always kept on separate farms under different systems of management. Only sheep are allowed to graze, but goats are kept in full confinement. Sheep in GAR and CIR are of the Javanese thin-tail breed and goats are of a medium size, and are the local type with some Ettawah characteristics. In addition to the selection criteria used for the baseline survey, willingness to cooperate for extended periods was important. In CIR, sheep and goat farmers were unequally distributed within strata and the sample was too small to allow equal sampling by species. Animal species was, therefore, not considered a criterion at this stage.

Table 1. General characteristics of the study areas.

	Upland (Garut)	Lowland (Cirebon)
Altitude (m)	>600	<20
Topography	Hilly	Flat
Area (ha)	2170	1080
Population	13000	14000
Precipitation (mm/year)	1130	2000
Temperature mean (°C)	25	28
Soil type	Inceptisol	Entisol
Cultivated land (ha):		
Paddi rice	305	755
Dry land	1250	55
Communal pasture (ha)	-	14
Small ruminants	3930	610

Source: Sabrani et al. (1982).

Experimental Design

Results of the monitoring program were used in the design of the mineral supplementation trial. During the monitoring period, one farm in GAR and two farms in CIR discontinued cooperation. To have equal treatment groups, the number of participating farms was reduced to 25 by eliminating farms with the least stable flocks in terms of size and composition.

Flock characteristics, feeding management, and general husbandry techniques made the application of more than a single nutritional treatment per farm virtually impossible. Consequently, the different mineral supplements were imposed on different farms; flocks or farms thus became the experimental unit.

Performance of young animals was selected as the main response variable. Although the value of reproductive performance as an index of productivity and nutritional status is recognized, measurements of reproductive parameters require extended periods of observations (generally 2 or more years) and heavy reliance of enumerators on the information of farmers. For on-farm measurements, growth rates based on weighings at regular intervals give a rapid indication of nutritional treatment effects. Evaluation of the long-term effects of mineral supplementation will take reproductive performance into consideration.

Farms were, thus, ranked on the basis of mortality of young animals and average pre- and postweaning weight gain corrected for litter size. They were then divided into five classes of productivity. Treatment groups were formed by random selection within each class and, for CIR, within animal species as well. Flock characteristics as reported 1 year before the supplementation trial are shown in Table 2. Farmers participating in the on-farm trials generally owned the small ruminants on their farm, although in or out sharing of mature animals did occur. Sharing arrangements for small ruminants are long-term; care and management of shared animals is similar to that of directly owned ones and is, therefore, not expected to affect the response. Farmers commonly share breeding males. On the basis of the flock composition in Table 2, and considering only the animals for which complete records were available, the proportion of growing young resulted in an average of 3.1 preweaning and 1.3 postweaning observations on growth rate per farm. Four postweaning weights on each postweaning animal were taken as the minimum number needed to estimate weight gain, which increased the yearly number of observations of postweaning animals.

Throughout the year the number of pre- and postweaning young is reasonably constant and no definite seasonal pattern has been established in breeding, birth, mortality, or off-take. Similarly, forage

Table 2. Size and composition of small ruminant flocks before the supplementation study.

	Upland (Garut)	Lowland (Cirebon)	
	Sheep	Sheep	Goats
Flock size	5.5	5.5	4.7
Flock weight (kg)	110.8	95.9	96.4
Flock composition (%)			
Mature males	4.4	6.9	7.7
Mature females	64.2	59.0	55.7
Postweaning males	6.4	7.7	9.4
Postweaning females	7.5	15.3	14.7
Preweaning young	17.5	13.1	12.4

mineral concentrations do not show important seasonal fluctuations, although liver mineral concentrations suggest increased requirements during the wet season (Prabowo et al. 1983). Sampling must, therefore, be continuous with special attention to performance of animals during the wet season (September-March). The supplementation trial was initiated after a 1-month preliminary period in May 1984. The results presented in this paper cover the period from May 1984 through to February 1985 and include, therefore, most of the wet season.

Five supplementation treatments were applied. They consisted of: (a) a control - no mineral or urea supplement, (b) common salt, (c) salt and $CaPO_4$, (d) complete mineral mixture including salt and $CaPO_4$, and (e) treatment (d) plus urea.

The supplements were provided in molasses-rice bran based blocks gelled by heating and the addition of MgO. The concentration of molasses was 50% and MgO 10%. Depending on the specific treatment, salt was added at 9%, $CaPO_4$ at 5%, complete mineral mixture at 3%, and urea at 7.5%. The remainder of the blocks consisted of rice bran. All ingredients with the exception of MgO are readily available in the villages, but the use of blocks is largely for experimental purposes. If the supplements prove to be effective, alternative means of supplementation can be considered.

Each farmer was provided with a specific block and new blocks were provided at regular intervals depending on flock size and rate of consumption. Average consumption per farm was between 2.5 and 3.0 kg/month in blocks. Farmers were informed of the purpose and details of the experiment but were not told which specific treatment they received.

Logistics and Data Collection

In continuation of a practice started before the supplementation trial a senior scientist met with all farmers each month. These meetings were initially organized to discuss general problems in local small ruminant production as they became apparent during the monitoring program. At the beginning of the supplementation trial the meetings focused on this subject.

The day-to-day care of the supplementation trial and data collection were in the hands of a two-man village staff team who were graduates from regional high schools or agricultural institutes. They were specially trained for the survey and monitoring program, lived in the villages, spoke the local dialect, and had the support of the village officials. Much of the information collected during the on-farm trials was similar to that of the monitoring study. Farmers and village staff were, therefore, familiar with the purpose and procedures of the measurements and questions. Observations included reproductive parameters, quantitative measures on feed offered and refusals, botanical composition of the diet, and changes in animal weights. In this paper, only the effects of supplementation on weight gain are reported.

Each farm was visited monthly for the specific purpose of data collection. For this purpose a predesigned form was used. Data collection relied primarily on direct observations by the village staff, but the presence of the farmer during the monthly recording was considered important. Farmers were given 1 or 2 days notice before the scheduled data collection. Visits were generally carried out in the afternoon immediately after farmers returned from their field or village work. This was also the time at which fresh feed was brought home or grazing sheep were returned to their barns.

The nutritional information was collected over the period of two consecutive days. On the first day, and before feeding, mineral blocks were checked, animals were weighed, and the amount of feed on offer recorded following sampling for the determination of botanical composition and dry-matter content. Feed residues were removed from feed troughs and pens. This process was repeated for the feed component on the next day, again before feeding, and this time feed refusals were weighed and sampled. The farmer was then interviewed to obtain general information on changes in flock size, birth or death of animals, source of the cut-and-carry feed, management practices, and animal health. Subsamples of the feed and refusals were sent to the research institute for determination of chemical composition. The monthly records of liveweights were used to determine growth rates using the linear regression technique.

The on-farm data collection required 1.5-3 hours per farm daily, limiting the number of farms that could be visited by the village staff to two per day. The maximum number of farms the two village staff can handle is, therefore, 25-30. Sample preparation, botanical identification of forage species, the logging-in of recorded data in the record books, and certain administrative duties require approximately 2 hours daily. In addition to the regular monthly visit, farms were briefly visited more frequently to check mineral blocks and the general status of the flock. If animals were grazed, feed availability, type and quality of the forage, distance from the farm, and duration of grazing were recorded.

The basis for the farmer's cooperation relates back to the incentives farmers received immediately before the monitoring study. At that stage farmers received one mature sheep or goat on conditions similar to those employed for local sharing arrangements. A written agreement was made up that committed farmers to return three postweaning young over a period of 5 years. The mineral supplementation trial was started in the fourth year of this agreement. Mineral blocks were provided at no cost to the farmers.

A senior scientist spends on average, 2 days/month in each village. In addition to the village staff, laboratory technicians, assistants for data management, and labourers were employed. Molasses blocks were prepared at the institute, but much of the work by the personnel at the institute was due to the decision to collect extensive secondary information. Although this data collection may not be absolutely necessary for the on-farm testing of improved feeding techniques, it can contribute significantly to the analysis of the results. It is estimated that, including the work of the senior scientists, 40 man-days per month are required at the institute for activities associated with the on-farm trials.

Requirements for equipment and vehicles were kept to a minimum. Equipment for the village staff was basic, consisting of scales to weigh animals and feed, a tattooing kit, and scissors for forage sampling, shearing, and hoof trimming. A simple drying oven based on a kerosene burner and forced convection was installed in each village. Transportation needs by the village staff were met by one motorcycle in each village. Project use of the motorcycle averaged 500 km/month. Mineral blocks and supplies were delivered by motor vehicle generally at the time of a visit by a senior scientist. The average monthly distance covered by a car for this purpose was 750 km.

Statistical Analysis

Results of the mineral study were analyzed as a randomized complete block design with the previous level of farm productivity (farm means for pre- and postweaning gain) as blocks and farm size as a covariance. Initially, the two villages were treated as separate experiments. For the lowland site CIR, animal species was included in the analyses of variance. Treatment differences between villages were compared in a separate analysis. Least significant differences were calculated for means of significant treatment effects. Statistical analyses, including calculations for minimum sample sizes were carried out as described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The survey and monitoring that preceded the on-farm trials were extensive. The large diversity among small ruminant producers and the complexity of small farming systems with integrated sheep or goat production make an in-depth diagnostic phase essential. The study of, or experimentation with, any one element within this farm system, requires a general understanding of the dynamics of the system if the correct inferences are to be made.

The information generated was essential for determining the design of the on-farm trials and identifying the degree of the interactions between the response variables and flock or farm characteristics. The monitoring study also provided an estimate of between-year variability in farm productivity, allowed the evaluation of farmers' commitment to long-term on-farm trials, permitted selection of feasible new technologies, and increased understanding and collaboration between researchers and farmers.

Effects of On-Farm Mineral Supplementation

The proportional stratified random-sampling technique used for the diagnostic study and the use of the same sample for the on-farm trials assured weighted representation of farm size in the sample. The classification of farms on the basis of previous productivity and the absence of a consistent relationship between flock size and productivity justifies the initial assumption of random distribution of flock size across treatments. Analysis of the data collected during the supplementation study confirms this for the lowland and upland sites. Average flock size in GAR (upland area) was 7.7±0.5 and in CIR (lowland area) 8.9±1.0. The inclusion of flock size as a covariate in the analyses was not effective. Weight gain and animal performance in general seem independent of flock size and, in as far as flock size is a measure of the farmer's economic interest in small ruminant production, animal performance seems to be independent of the economic importance of small ruminants in the farming system. It is noteworthy, however, that relative to the monitoring study (van Eys et al. 1984) flock size increased in both locations. This is particularly true for CIR where the increase averaged 78%; in GAR flock size increased by 40%. The continuous interest shown by outsiders, in this case the research staff, and the expectation of higher levels of production with increased involvement of scientists may have stimulated farmers to direct a greater effort toward small ruminant production. As a consequence of the increase in flock size, farm means for weight gain of pre- and postweaning animals are based on a larger number of observations than originally projected.

The effects of minerals or mineral-urea supplementation on weight gains of young are shown in Table 3. For the purpose of comparison, average pre- and postweaning gain observed during the monitoring period is included. The supplementation trial per se did not seem to affect animal performance on farms that did not receive a supplement. Weight gain of control animals was similar to that of animals before the on-farm trial.

Growth rates of sheep and goats in CIR were not significantly different, and the two species responded similarly to supplementation. Differences between the two locations were large ($P < 0.01$) for pre- and postweaning gain. The location by treatment interaction however, was not significant and the effect of supplementation was, therefore, similar for the two locations regardless of differences in, e.g., climate and feeding or management system. This in fact suggests that the results of this study may be applicable to a wider area.

Mineral supplementation increased ($P < 0.01$) the weight gain of both pre- and postweaning animals, and the effect was similar for the two animal classes. As the mineral supplement became more complete, animal performance increased. The highest gains were,

Table 3. Pre- and postweaning weight gains of small ruminants provided with mineral or mineral-urea blocks (g/day).[a]

Treatment	sp[b]	Upland (Garut) <90 days	Upland (Garut) 90-365 days	Lowland (Cirebon) <90 days	Lowland (Cirebon) 90-365 days
Control	SH	71^{a}	40^{a}	61	31
				)49^{a}	)39^{a}
	GO	-	-	29	51
NaCl	SH	92^{ab}	62^{ab}	63	33
				)56^{ab}	)36^{a}
	GO	-	-	44	22
NaCl + $CaPO_4$	SH	110^{bc}	58^{ab}	56	53
				)57^{ab}	)55^{ab}
	GO	-	-	59	59
Complete mix.	SH	124^{cd}	75^{b}	117	54
				)102^{b}	)69^{b}
	GO	-	-	79	93
Complete mix. + urea	SH	102^{bc}	63^{b}	95	49
				)82^{b}	)48^{ab}
	GO	-	-	64	47
SEM		27	17	25	22
Previous year[c]	SH	82	45	70	24
	GO	-	-	69	38

Note: Figures in each column, under the headings "Upland" and "Lowland," without the same superscripts are significantly different ($P < 0.05$).

[a] Pre- and postweaning weight gain is based on farm means and adjusted for sex and litter size. Preweaning = <90 days of age, postweaning = 90-365 days of age.

[b] SH = sheep, GO = goats.

[c] Results of monitoring study (1982-83).

therefore, observed on farms that received the complete mineral mixture, although differences between these farms and those on which salt or salt plus calcium phosphate were fed were not significant at the conventional significance level ($P \ 0.05$). Comparisons of individual means indicated only significant differences between extremes in mineral supplementation. These results are in agreement with previous research on the mineral status of ruminant livestock in this area. With the exception of Na, no extreme mineral deficiencies have been identified, although marginal deficiencies have been noted for P, Cu, Zn, selenium (Se), and iodine (I) (Panggabean et al. 1982; Sutrisno et al. 1982; Prabowo et al. 1983). The absolute differences between means is larger than expected and this may be associated with the timing of the trial. The data were collected during only part of the dry season but covered most of the wet season when mineral nutrition appears most critical (Prabowo et al. 1983).

There was no benefit from the addition of urea to the molasses blocks. Dry and mature roughages of low N content are traditionally mixed with green forages (van Eys et al. 1983) and these appear to provide adequate levels of rumen soluble nitrogen.

In addition to weight gain, lamb and kid mortality, litter size, and birth weight were studied. None of these variables was significantly affected by the treatment, although mortality tended to decrease with increasing completeness of the mineral supplement. For GAR, lamb mortality decreased from 8.0 to 0% and for CIR the mortality dropped from 24 to 3%. A larger number of observations is required to determine the importance of mineral nutrition in reducing on-farm mortality of young animals.

Required Sample Size

The minimum sample size for this type of experiment was calculated on the basis of the observed variance between farms. To detect differences of 20% between treatments at $P = 0.05$ and with 90% confidence, 7-8 farms per treatment are required in the case of preweaning animals and 4-6 farms per treatment for postweaning animals. This requires 40 farms in each location if the effect of mineral supplementation is to be evaluated on preweaning animals. The between-farm variability for postweaning gain appears to be less, and the actual number of farms used is adequate to estimate treatment differences at the set level of confidence and probability. The lower variability for postweaning gain is not associated with a larger number of observations per farm. The average number of obser ations on preweaning animals in GAR was 4.9 and in CIR 4.0, while the number of postweaning animals per farm averaged 4.6 and 4.0 for GAR and CIR, respectively. The lower variability for this animal class is likely due to the larger effect of diet on their performance and the more accurate estimation of weight gain based on a larger number of weighings per animal. On-farm evaluation of dietary treatments is, therefore, more efficiently carried out by using postweaning animals.

The supplementation trial is an example of an on-farm trial that is relatively easily controlled and requires only limited amounts of investments in equipment and feed. As for all on-farm trials, requirements for manpower are relatively large, mainly due to the need for constant supervision and the collection of secondary information. In this case, the permanent stationing of a village staff with whom farmers are familiar was found to be effective, although a carefully controlled scheme of incentives and responsibilities is needed to maintain their effectiveness. Regular visits by a senior scientist are necessary to maintain a collaborative spirit between farmers, village staff, and the research institute. Super isory control is necessary because frequent visits foment prestige, respect, and confidence. In this case, the senior scientist is the person responsible for maintaining contact with local officials and extension service. Cooperation of the extension service is essential and they should be included in the program as much as possible.

Results of this mineral and urea supplementation trial reflect some of the advantages and difficulties in technology verification experiments with smallholders. Among the disadvantages associated with trials on small farms are the possibilities for close experimental control on individual animals and access to secondary data. The lower importance of small ruminants on these predominantly crop-producing farms and the low level of investments associated with their production tends to increase the willingness of farmers to cooperate in on-farm trials. Furthermore, the application of one treatment on a number of farms different in management and productivity allows a wider application of the result. On the other hand, the necessity of applying a single treatment per farm confounds within treatment variability with variation between farms.

Implications for Future Research

The choice of farms as the experimental units and their use as replications at the given number of farms per treatment limits precision and, therefore, the likelihood of detecting significant treatment effects at conventionally used levels of significance. Under these conditions of on-farm trials it is justifiable to put more emphasis on average treatment effects and relax the test of significance. Loss in precision is compensated for by increased relevance. The higher risk of faulty inferences from such analysis, however, is recognized and implies the need for repeated studies and detailed information on the situation that the new technology seeks to improve. The secondary information collected before or during the trials and the results of station research are of special importance here.

Variability in weight gain within farms is larger than among farms. Owing to the small number of observations per farm, performance of individual animals can have a large effect on farm averages and, because farm conditions cannot be standardized, on variability among farms. One possibility for improving research efficiency would be to limit the number of treatments or increase the number of farms. Reduction in the number of treatments will also reduce the information provided by the experiment. Expanding the sample size or increasing the number of farms per treatment allows greater selection possibilities on a larger number of criteria, which should result in increased precision.

Eliminating part or all of the secondary data collection to increase the number of farms that can participate, or decreasing costs by reducing labour requirements, removes the essential reference points. If the primary purpose is to increase sample size then research efficiency may be increased, although the commitment and stability of the additional farms are expected to be less, and the quality of the inferences compromised. Reductions in costs at the expense of secondary data collection will also limit the applicability of the results and seem only justifiable when the results of collected data are similar to those obtained during the diagnostic phase. Another consideration is that a decrease in labour expenses, such as the village staff, is likely to reduce research quality through its effect on supervision and farmer-researcher contact.

Alternatively, the current on-farm trials could be extended for a longer period. Extending the duration of the trials will increase the number of observations and, consequently, the reliability of the results and tests of significance. Table 4 indicates that at the current level of reproductive efficiency eight farms are needed per treatment to achieve an acceptable level of confidence for preweaning animals and six farms for postweaning animals. Extension of the study to 15 months for preweaning lambs and kids or 11 months for weaned animals would provide a similar number of observations on individual animals. However, owing to the larger within- than between farm variability, longer observation periods would be necessary.

Table 4. Minimum number of farms required per treatment to detect 10 and 20% difference in weight gain at 0.10 and 0.05 statistically significant levels.

	Upland (Garut)		Lowland (Cirebon)	
	10%	**20%**	**10%**	**20%**
Preweaning				
P <0.10	13	4	19	5
P <0.05	32	8	27	7
Postweaning				
P <0.10	9	3	14	4
P <0.05	12	4	22	6

Given the small differences in weight gain between the control group and the changes in weight observed during the monitoring study (Table 3), research efficiency could be increased by including an additional treatment on all or a subset of farms. Preparations are made to include the feeding of tree legumes as a retrospective study using differences between sequential years to measure the effect of legume tree introduction. When the new treatment is obvious to the farmers, prospective randomized studies are difficult to carry out. The use of historical controls offers a feasible alternative.

With supplementation proven to be useful, farmers are likely to continue mineral supplementation, in part due to the low cost involved. It is unlikely, however, that minerals will be provided in blocks unless an inexpensive way of mass production can be developed, for instance, by cooperatives. Alternative means of supplementation should be studied.

On-farm verification trials have a large demonstrative component. The demonstrative aspect of these trials could be carried out more efficiently by single demonstration units in a number of villages. A project along these lines is currently under way. For this purpose, the research institute and a small group of farmers enter into a joint venture. Small ruminants are managed according to local practices. In turn for the institute's investments in barns and animals, according to locally established sharing arrangements, farmers comply with the planned application of improved animal husbandry techniques on the demonstration farm.

REFERENCES

Knipscheer, H.C. and Soedjana, T.D. 1982. The productivity of small ruminants in West Javanese farming systems. Small Ruminant-Collaborative Research Support Program. University of California, Davis. Technical Report Series, No. 13.

Norman, D.W. 1978. Farming systems research to improve the livelihood of small farmers. American Journal of Agricultural Economics, 60, 813-818.

Panggabean, T., Yates, N.G., and Winugrohu, M. 1982. The response to mineral supplements in Indonesian sheep fed native grass. Balai Penelitian Ternak Research Report, 44 p.

Prabowo, A., van Eys, J.E., Mathius, I.W., and Soekanto Lebdosoekoja. 1983. Trace mineral status and the effect of mineral supplementation in Javanese Thin-tail sheep. Proceedings Vth World Conference on Animal Production, Tokyo, Japan, Vol. 2 pp. 389-390.

Sabrani, M., Sitorus, P., Rangkuti, M., Subandryo, Mathius, I.W., Soedjana, T.D., and Semali, A. 1982. Laporan survey baseline Ternak Kambing & Domba. Balai Penelitian Ternak, Bogor, Indonesia, Small Ruminant-Collaborative Research Support Program.

Snedecor, G.S. and Cochran, W.G. 1967. Statistical methods. Sixth Edition. Ames, Iowa, USA, The Iowa State University Press.

Sutrisno, C.I., Sutardi, T., and Sulistyono, H.S. 1983. Status mineral sapi potong di Jawa Tengah. Proc. Pertemuan Ilmiah Ruminanasia Besar. Puslitbangnak, Bogor, Indonesia, pp. 57-63.

Thomas, N., Mathius, W., and Sabrani, M. 1982. Small ruminant production in West Java; Methodology and initial results. In Fine, J.C. and Lattimore, R., (ed.), Livestock in Asia: Issues and Policies, Ottawa, Canada, International Development Research Centre (IDRC), pp. 161-166.

van Eys, J.E., Mathius, I.W., Thomas, N., Rangkuti, M., and Johnson, W.L. 1983. Forage composition of hand-fed sheep and goat diets in West Java. Proc. Scientific Meeting, Sheep and Goats in Indonesia. Bogor, Ciawi, Indonesia, pp. 42-47.

van Eys, J.E., Mathius, I.W., Pulungan, H., Rangkuti, M., and Johnson, W.L. 1984. Small ruminant production in West Java; results of one year monitoring by the nutrition village monitoring program. Bogor, Indonesia, Balai Penelitian Ternak, 29 p.

ON-FARM TRIALS WITH AMMONIATION OF STRAW IN EGYPT

H. Yackout, M.K. Hathout, H. El Nouby, and T.J. Barker

Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt

Abstract *The nutritive value of crop residues could be effectively increased by treating rice straw with ammonia. In the beef project conducted at the Animal Production Research Institute, it was found that average feed intakes and daily weight gains were improved when treated straw was fed to fatten cattle. The results were used to promote on-farm use of ammonia.*

Thirty farmers from the Beheira Governorate who were using ammonia or urea techniques were selected to examine their response to the use of the new technologies. Project staff demonstrated the technologies and followed up with regular visits to these farmers to collect information and monitor progress. A questionnaire was designed to correlate data.

It was calculated that 10 t of ammonia-treated straw can save the farmer up to 3 t of concentrates. Dairy farmers were unwilling to disclose production figures but large and public farms use ammoniation. The urea treatment of straw, for reasons of scale, suited small farmers better, although extra labour and much water had to be employed.

The study confirmed the importance of extension activities to transfer the new technologies. It also measured the response of farmers with respect to benefits obtained and problems encountered.

On-farm trials proved to be an effective tool to examine the adoption of the new technologies through measuring their applicability on the farms, animal performance, and the response of the farmer.

Résumé *On accroîtrait réellement la valeur nutritive des résidus de récolte, de la paille de riz par exemple, grâce à l'ammonisation. Le projet sur le boeuf mené à l'Animal Production Research Institute, a permis de conclure que la consommation alimentaire moyenne augmentait et que les bêtes prenaient davantage de poids chaque jour quand on se servait de paille traitée pour les engraisser. On a donc utilisé ces conclusions pour promouvoir l'ammonisation chez les exploitants.*

On a alors sélectionné 30 agriculteurs du gouvernorat de Beheira, qui utilisaient les techniques à base d'ammoniaque et d'urée, pour analyser leurs réactions face à de nouvelles technologies. Après avoir fait une démonstration des nouvelles technologies, le personnel du projet a visité régulièrement les exploitants pour recueillir des informations et observer les progrès accomplis. Un questionnaire a été préparé dans le but d'établir la corrélation entre les données.

On a calculé que 10 t de paille traitée à l'ammoniaque pouvaient faire épargner au propriétaire jusqu'à 3 t de concentrés. Les producteurs laitiers ont refusé de révéler leur production, mais on sait que des exploitations de grande taille ou publiques emploient l'ammonisation. Le traitement de la paille à l'urée, étant donné ses exigences, convenait davantage aux petits exploitants, quoiqu'il a demandé un labeur plus intense et l'utilisation d'une grande quantité d'eau.

L'étude a confirmé l'importance des activités de vulgarisation pour le transfert des nouvelles technologies. Elle a aussi permis de connaître les réactions des agriculteurs aux avantages de nouvelles technologies mais également aux problèmes qu'elles posent.

Les essais sur le terrain s'avèrent un instrument efficace pour analyser le degré d'acceptation des nouvelles technologies, puisqu'ils permettent de mesurer leur niveau d'application à l'exploitation, la performance des animaux et la réaction de l'exploitant.

In Egypt there is an estimated 39% short fall (2.7 t of starch equivalent) of available ruminant feed supplies particularly in the summer season. At present, there is a growing attention being focused in Egypt on the use of crop by-products for ruminant feeding and methods of improving them. The United Nations Development Programme (UNDP), the Food and Agriculture Organization of the United Nations (FAO),

and the Ministry of Agriculture (MOA) - Beef Project, situated just outside Alexandria, tried different systems to maximize the effective use of available agroindustrial by-products.

Treatment with sodium hydroxide was unsuccessful because of the difficulties of applying the chemical in a low-cost system or of chopping rice straw during application. Furthermore, in a pilot trial, water buffalo did not respond to NaOH-treatment straw where cattle did respond. There were also fears of increasing the soil salt content. On the other hand, the urea treatment showed great promise but, in the end, farmers did not use the system. Straw treated with anhydrous ammonia improved both production and intake in buffalo and cattle in a series of three trials (Sundstol et al. 1977; Klopfenstein 1978). In the project, these trials and other studies were conducted to examine the effect of ammonia treatment on composition, digestibility, and feeding quality of the treated by-products. It was also found that ammoniation increased crude protein content of the rice straw from 4 to 8%.

The first trial with ammoniation straw was carried out with male water buffalo, and the results showed an increase of 14% in intake over untreated straw, with the daily weight gain improving from 0.024 kg to 0.168 kg/day. Higher levels of concentrate feeding improved overall performance (intake, daily gain, and feed efficiency). The second trial was conducted with 120 cross-bred steers (predominantly Hereford crosses) divided into 12 groups of 10 animals each. Six groups were put on treated straw and six groups were on untreated straw. All straw was fed ad libitum. The rest of the ration was made up of six levels of concentrates from 1 kg/head per day increasing in 1 kg increments. The results of the experiment showed that:

(a) Ammoniation of straw at all levels of concentrate feeding significantly improved intake, liveweight gain per head per day, and improved feed efficiency (conversion ratio);

(b) Ammoniation of straw can save concentrates while achieving the same weight gain per day or improve weight gain when using a particular level of concentrate feeding; and

(c) The extra benefit of ammoniation depends upon the level of concentrates used in the feeding program.

However, it was calculated from the intake and weight gain figures that ammoniation of 1 t of straw saved about 0.25 t of concentrates on average.

After such positive results, the project instituted methods of transferring this new technology to the farmers. At the same time, the project decided to measure the farmers' responses to this technology. In addition, the relative merits of anhydrous ammonia and urea as the most appropriate chemical for straw treatment were measured. Ammonia is produced in the local fertilizer industry as a precursor of urea and so both products are locally available. Ammonia appears to have the advantage because of the relative simplicity of application. The use of urea requires greater labour per unit of straw, which discourages the farmer from using it. Moreover, there is a risk of urea toxicity if it is incorrectly used.

The method of distribution undertaken in the project was to establish two distribution centres in Beheira Governorate, which is located in the Northwestern area of the Delta. The centres were completed and opened for operation in May 1983. The livestock population in Beheira Governorate is as follows: 206,000 water buffalo, 382,000 cattle (baladi, Freisian, cross-bred), 112,000 goats, 230,000 sheep and 201,000 others (horses, mules, donkeys).

The climate is Mediterranean in character with mild winters accompanied by rain showers and long dry, fairly hot, summers. Mean annual rainfall ranges from 180 mm along the coastal ridges to less than 60 mm in the southern part of the new lands. Maximum mean monthly temperatures are 32°C, minimum night temperatures are 4.6°C. Mean relative humidity is 60% and the dominant wind directions are southwest and northeast.

Thirty farmers from Beheira Governorate were selected for interviews. This represented 25-30% of those already using the feeding/ammonia system purchased from the distribution centres set up by the project. The purpose of the questionnaire was twofold: first, to examine the response of the farmers to the new technology of feeding and, therefore, to establish its feasibility and applicability on the farm; and second, to measure the response of the farmer's cattle. Meanwhile, project staff gave advice to farmers on mixing ammoniated crop residues with available feeds for different types of livestock.

MATERIALS AND METHODS

The project pilot distribution centres were established in two areas. The first area at El-Nahda (50 km from Alexandria on the desert road) represents the new reclaimed lands and the other at Itay El-Baroud (85 km from Alexandria on the agricultural road) represents the old valley lands. The investigation was limited to farmers in these areas who were selected for the questionnaire on the basis of two criteria: (a) farmers who had joined the project earliest in the program and were, therefore, most experienced under operating conditions and, (b) those farmers who were willing to respond to the questionnaire.

It should be noted that all farmers were expected to pay the price of ammoniation as laid down by the project. This price was calculated to enable the distribution centre to be operationally self-sufficient, with a modest profit margin. Eight stacks (2.5 t size) were ammoniated free for demonstration purposes at the very start of the distribution campaign. Farmers studied were divided into the following categories based on cattle numbers:

(a) Small: Farmers who own from 1 to 5 head (cattle and buffalo),

(b) Medium Farmers who own from 5 to 20 head (cattle and buffalo),

(c) Large: Farmers who own more than 20 head (cattle and buffalo), and

(d) Publically owned government farms.

The first demonstration of ammoniation was carried out at El-Nahda with 14 small farmers in two villages. They were not receptive to this technology. In one of these trials, staff attempted to collect from several farmers the straw to be ammoniated in one collective stack for the village, but the results were not satisfactory. Quarrels among the participants broke out when they came to collect their bales after treatment. Moreover, security and maintenance of the stack and its plastic was not the responsibility of any specific participant, which resulted in torn plastic and poor ammonia absorption. Therefore, this straw-treatment technique did not seem to be readily applicable to the small farmers as a group. As a result, our attention turned to investigate urea treatment of straw as an alternative for small farmers. The numbers of farmers questioned in each farm size category of our investigation are shown in Table 1.

On the first visit to each farmer, the project staff introduced the new technology to him and his neighbours and explained the advantages. He was also given a leaflet on the subject with instructions on how to prepare a stack in accordance with project specifications for ammoniation or for the use of urea. On the second visit the project staff demonstrated the technology to the same farmers. The following are the steps for the ammoniation technique:

(a) Build a 10 t stack of straw with the dimensions 2 m x 1.5 m x 2 m.

(b) Cover the stack with a plastic sheet tightly sealing the edges with soil.

(c) Insert a hose pipe inside the stack and inject ammonia from a pressure tank at the rate of 30 kg of ammonia per tonne of straw (3%).

(d) The stack is left covered for a treatment period lasting 15-20 days depending on the temperature.

(e) Uncover the stack and leave it for 2-3 days to release excess ammonia. The straw can then be fed to livestock.

There are two standard sizes of straw stacks calculated to make the best use of the plastic sheets, 2.5 t and 10 t. By providing an alternative small stack

Table 1. Distribution pattern of selected farms according to type of treatment and holding size.

Treatment	Category of holding				Total
	Small (a)	Medium (b)	Large (c)	Public (d)	
Ammonia	-	6	14	3	23
Urea	6	1	-	-	7

it was hoped to offer opportunities for all farmers. Some problems arose in trying to persuade farmers to build stacks of the correct dimensions. This problem did not exist on second and subsequent stacks. Damage to the covering plastic sheet was another problem usually caused by the curiosity of village children and their sticks or by stray animals. Damaged plastic resulted in loss of ammonia and suboptimal improvement in straw quality.

The urea treatment was carried out using the following steps:

(a) A plastic sheet was spread on the ground and straw for treatment was placed on it.

(b) Five percent of urea was dissolved in a quantity of water equal to the weight of straw.

(c) This solution was spread over the straw, which was then wrapped and sealed in the plastic sheet and left for 21-30 days depending on the temperature.

(d) The straw was uncovered and fed to animals after aerating for 3 days.

When the urea system was applied on the farm for the first time by the project staff, it required the assistance of the owner and two of his neighbours to complete the job satisfactorily. On subsequent occasions the farmer had to rely on his own labour and that of anyone he could persuade to help him. This made the system inconvenient for a large number of small farmers. Other farmers used old fertilizer bags for urea treatment. These bags were split in half and sewn together into a large sheet. This created extra work for the farmer's family, poorer results because of leakage of the urea solution through the sewn bags and, in four out of six cases, too great a burden on the family labour who had to provide the additional water for treatment.

Project staff questioned farmers on several visits (an average of five visits per farmer) over the period 1 March-31 December 1984. The information collected on the questionnaire included the size of farm, the number and type of animals, the feeding system used, the type of by-product fed, and the feeling of the farmer toward the new technology. His production levels and whether he bought a second (or more) ammoniation treatments were of particular interest. In most cases, production figures were not available or were suspect, particularly for milk producers who did not always know precisely their own production data.

Two types of visits were required when servicing the needs of the farmers and the questionnaire:

(a) Routine service given by the project staff to any farmer requesting ammoniation. The service was supplied by the distribution centres and the farmer was charged the price of the plastic sheet, delivery cost for the plastic and ammonia, and the costs of injection.

(b) The need for following up the selected farmers by the project staff to monitor their progress and the use of treated straw.

At the start of the distribution effort, the project initiated an advertising/information campaign. This consisted of (a) inclusion of the ammonia story in established agricultural extension broadcasts, (b) posters and leaflets printed and circulated in the villages, (c) briefing and discussion sessions for extension staff in the farming areas, and (d) demonstrations for farmers in which eight 2.5-t stacks were ammoniated free.

When contact had been made with a particular farmer, efforts were also made to contact his neighbours. The farmers paid for the delivery of ammonia and the plastic sheets. These were supplied by 1-t tanker trucks (one in each area). Extension support was also given by the project. The extension staff consisted of two officers, one based at each centre, and two truck drivers who were literate and trained in the ammoniation technique.

RESULTS AND DISCUSSION

Methods of Communication

Analysis of how farmers first became acquainted with the ammonia system is shown in Table 2. The

Table 2. Different communication sources as a reason for technology application.

Source	Ammonia treatment	Urea treatment
Centre staff and extension	13	2
Neighbour	6	4
Poster	8	-
Leaflet	10	-
Radio	4	4

results show that the project staff created the greatest interest, however, the various channels of media did much to spread the word. In the future it might pay the project staff to use mass media channels more extensively (radio, television) and so orient their professional efforts for servicing farmers, development, and research. The extension work should perhaps be handed over to the extension department.

Type and Number of Animals Kept by Farmers

Expanding sales of the ammonia system make it difficult to achieve a truly representative sample. The objective of the questionnaire was to establish, from those farmers with most experience of the system, whether it was effective and economic.

Data presented in Table 3 show the animal populations on different categories of farms. Urea treatment was used on six small farms in category (a) and only one farm in category (b). The average number of animals in category (a) was one head of dairy and one beef cattle. Ammonia treatment was not used by any farmer in category (a); however, six farmers from category (b), 14 farmers in category (c), and three large state farms (category (d)) used ammonia. The ratio of dairy cattle to beef was 0.6, 0.8, and 2:1 for categories (b), (c), and (d), respectively.

Table 3. Type and numbers of animals kept by participating farmers.

	Size of holding							
	Small (a)		Medium (b)		Large (c)		Public (d)	
Treatment	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef
Ammonia			(1) 3	7	(1) 8	15	(1) 300	150
			(2) 4	10	(2) 15	30	(2) 120	90
			(3) 1	6	(3) 11	13	(3) 300	120
			(4) 5	6	(4) 10	18		
			(5) 4	13	(5) 20	25		
			(6) 13	5	(6) 15	23		
					(7) 20	-		
					(8) 25	3		
					(9) 30	25		
					(10) 12	30		
					(11) -	25		
					(12) 22	10		
					(13) 13	17		
					(14) 8	14		
Total			30	47	209	248	720	360
Mean			5	8	14.9	17.7	240	120

(continued)

Table 3. Concluded.

Treatment	Size of holding							
	Small (a)		Medium (b)		Large (c)		Public (d)	
	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef
Urea	(1) 1	3	(1) 4	10				
	(2) 3	2						
	(3) -	3						
	(4) 3	-						
	(5) 2	-						
	(6) 1	1						
Total	10	9	4	10				
Mean	2	1	-	-				

Feeding System

At the time of recording the feeding system normally used by the farmers, it was established that they followed a very similar pattern. In winter, the diet was generally 20 kg fresh berseem, 3 kg concentrates (when available), and 5 kg of rice straw daily. A similar diet was used in summer but without berseem, which is not grown at that time. No loose straw was ammoniated by the project. It was always prebaled by the farmers. All straw was treated in 10-t stacks with the exception of one farmer who treated a series of 2.5-t stacks. On the other hand, straw used in urea treatment was all loose straw, each batch averaging 150 kg in weight.

Response of Farmers and Benefits Obtained from the Use of the New Technologies

Response of the farmers was measured by their willingness to ammoniate a second and subsequent stacks of straw and still pay the full cost of the treatment. The figures for this repeat service from the questionnaires are shown in Table 4. These figures suggest that medium, large, and public farms were eager for the ammoniation of straw because repeat business on these farms ranged from 78.6 to 100%. Small farmers, however, were not keen to repeat the urea treatment. Only 33.3% of category (a) and none of category (b) tried the system a second time.

As stated earlier, farmers were generally reluctant or were unable to give details of production improvements resulting from ammoniation, but their observations are recorded in Table 5. Clearly, they would not spend more money and time on a system that did not benefit them. This type of improved feeding system can only be beneficial for Egypt and other developing countries where feed resources are scarce. This is particularly appropriate in situations where expensive, imported concentrates can be saved in the proportions suggested earlier (30 kg ammonia saves up to 0.25 t of concentrates).

Table 4. Response of farmer measured by repeatability of treatment.

Holders	Number	% of total	Repeat business	% of initial
Ammonia treatment				
Small (a)	-	-	-	-
Medium (b)	6	26.1	5	83.3
Large (c)	14	60.9	11	78.6
Public (d)	3	13.0	3	100.0
Total	23	100.0		
Urea treatment				
Small (a)	6	85.7	2	33.3
Medium (b)	1	14.3	-	0.0
Large (c)	-	-	-	-
Public (d)	-	-	-	-
Total	7	100.0		

Policy Implication

As a result of the success of the new technology, the Minister of Agriculture has set up a new unit within the Animal Production Research Institute called the "Special Unit." The purpose of this unit is to promote and expand facilities for ammoniation and the use of other agroindustrial by-products. The on-farm questionnaires did not influence this decision but do support it.

Further qualification of the benefits of ammoniation are necessary, in particular, detailed milk production work. The optimum straw moisture levels for ammoniation and the duration for covering stacks at different ambient temperatures need more thorough investigation.

Table 5. Farmer responses[a] for benefits of and problems encountered in ammonia and urea treatment of straw.

Type of treatment	Benefits of treatment	Number	Problems encountered	Number
Ammonia	Increased milk production	6	Need extra labour	3
	Increased fat percent	13	Need extra place	5
	Cattle healthier[b]	16	Extra feed costs	2
	Increased daily gain	17		
	Saved concentrate	21		
Urea	Increased milk production	2	Need extra labour	5
	Increased fat percentage	1	Need lot water	7
	Increased daily gain	7	Need extra place	3
	Cattle healthier[b]	6	Extra feed costs	1
	Saved concentrate	7		

[a] One farmer could state more than one benefit.

[b] Farmers who used molasses as liquid supplement reported that their cattle were healthier.

Conclusion

The original purpose of this paper was to discuss a series of feeding experiments conducted on private, joint venture, and state farms. In every case the experiments were too late in starting. The main reasons were

(a) Farmers feared loss of production and earning if the feeding system proved unsuccessful.

(b) They feared the extra costs imposed.

(c) The extra labour required was difficult to find because of limited labour availability, insufficient cash to hire labour, etc., (particularly for urea).

(d) Trials were started and then stopped because of changes in diet occasioned by the lack of vital resources.

(e) The lack of accurate recording. Farm employees did not always have time for accurate recording and if an outsider did the recording it would often change normal commercial procedures.

(f) State farms feared reprisals for experiments that might turn out badly.

It is hoped that the new experiments now under way will prove more successful in demonstrating accurate milk production improvements. In the meantime, the questionnaire approach, particularly in an environment of commercial distribution, which the project has tried to create, was felt to be a valid measure for on-farm benefits. The system is now becoming well established in Egypt. There is now a waiting list of farmers who wish to pay for ammoniation, but the project has insufficient equipment to deliver. This, surely, is the ultimate on-farm trial.

REFERENCES

Klopfenstein, T.J. 1978. Chemical treatment of crop residues. Journal of Animal Sciences, 46, 841.

Sundstol, F., Coxworth, E., and Mowat, D.N. 1977. Improving the nutritive value of straw and other low-quality roughages by treatment with ammonia. World Animal Review, 26, 13.

IRRIGATED SUMMER FORAGES FOR SMALL DAIRY FARMS IN THE RAHAD AGRICULTURAL SCHEME (SUDAN): ON-FARM TRIALS

R.S. Modawi,[1] A.Y.M. Nour,[1] A.H. Ahmed,[2] A.B. Mohamed,[1] and A.E.S. Ibrahim[3]

[1]Faculty of Agricultural Sciences, University of Gezira, P.O. Box 20, Wad Medani, Sudan, [2]Farming Systems Program, ICARDA, P.O. Box 5466, Aleppo, Syria, and [3]Faculty of Agriculture, University of UAE, P.O. Box 15551, Alain, UAE

Abstract *The Rahad Agricultural Scheme (Sudan) is devoting 1680 ha to forage production for the support of about 10,800 head of dairy cattle. Distribution of 400 tenancies, of 4.2 ha each, started in the 1982/83 season. On-farm trials (OFT) are an integral part of the research project aiming at the improvement of the dairy-production systems in the scheme. The primary objective set for OFT is to help researchers develop a realistic understanding of the traditional production system as well as the identification and introduction of practical ways for improvement.*

In the first year, five tenants were selected to participate in OFT. Three were chosen for the purpose of evaluating forage yields and crop management practices, whereas the other two were identified for the evaluation of both forage and milk production. Tenants were interested in the objectives of the trials and were very cooperative.

Results indicated inefficient utilization of the produced forage, although tenants are capable of getting reasonable yields. Many practical reasons were found behind such a behaviour. In this respect, OFT served as a useful technique for complementing information collected about farmers' practices through other means. On the other hand, OFT achieved the objective of defining other production alternatives available to the tenants. Self-confidence developed by the trial tenants and neighbours and their belief in the work the

research team is trying to do stands as an accomplishment by itself.

Résumé *Le Rahad Agricultural Scheme, au Soudan, consacre 1 680 hectares à la production de fourrage pour nourrir un troupeau laitier de quelque 10 800 têtes. On a commencé, au cours de la saison 1982-1983, à distribuer 400 baux à ferme de 4,2 hectares chacun. Or les essais sur le terrain constituent un élément essentiel du projet de recherche dont l'objectif est d'améliorer les systèmes de production laitière. Le but premier des essais est d'aider les chercheurs à comprendre d'une manière pragmatique le système traditionnel de production, et aussi à envisager de façon tout aussi pragmatique l'identification et l'introduction de moyens pratiques pour l'améliorer.*

Durant la première année, 5 fermiers ont été choisis pour participer aux essais, 3 dans le but d'évaluer les rendements en fourrage et les méthodes de gestion des cultures, 2 pour l'évaluation des productions et fourragère et laitière. Intéressés par les objectifs des essais, les fermiers ont pleinement collaboré.

Bien que les fermiers soient capables d'atteindre des rendements en fourrage acceptables, les résultats ont montré qu'ils n'avaient pas su utiliser de manière efficace leur production. On a trouvé plusieurs raisons pratiques pour expliquer ce fait et, en ce sens, les essais se sont avérés une technique bien utile pour compléter les renseignements déjà recueillis ailleurs. D'autre part, les essais ont permis de déterminer d'autres moyens de production accessibles aux fermiers. Que ces fermiers et leurs voisins aient développé une confiance en eux-mêmes et aient jugé valables les travaux de l'équipe de recherche est, en soi, une réalisation.

The Sudan is the richest among all Arabic and African countries in terms of its animal resources. There are about 56 x 10^6 head of animals, estimated in 1982, with cattle comprising 37% of the total population. Sheep, goats, and camels constitute 32.3, 24.6, and 5% respectively. The animal sector contributes an average of 30% to the total agricultural product representing 10% of the gross national product and, in turn, provides 3-8% of the country's hard currency earnings (AOAD 1983).

In the central region, where the major agricultural schemes were established, about 3, 4.5, and 2.6 x 10^6 head of cattle, sheep, and goats, respectively, are found. Despite the presence of such large numbers of animals, their productive role had almost been neglected when most of the irrigation schemes were planned and established. As a consequence, animals are left to live on crop residues and open grazing during the period from August to February. In summer (March-July) these animals, especially cattle, suffer both nutritional deprivation and inadequacy of feeds, which leads to considerable losses each year. Recently, the realization of the importance of integrating both animals and crops (prompted by the scarcity and poor quality of animal products) inspired policymakers to devote certain areas of the newly developed agricultural schemes, such as Rahad, to forage production.

The Rahad Agricultural Scheme is a publicly administered corporation that extends along the east bank of the Rahad river over an area of about 126,000 ha. The scheme area is a flat plain with highly fertile clay soils and is irrigated by gravity from the Rahad seasonal river, which is backed up by a set of pumps on the Blue Nile (200 km north of the Reseries Dam) delivering water to the fields through a canal system. On the other hand, annual rainfall is low; the average annual rainfall was 93 mm for the past 3 years, but a total of only 61 mm was recorded last season.

Medium staple cotton, groundnuts, and sorghum are the three rotational field crops. The cotton area makes up about 44% of the total scheme area. Sorghum and groundnuts are usually grown in an area equivalent to half that of cotton for each crop. Vegetables are also grown but on a limited scale that does not exceed 1.4% of the total area.

Besides the agricultural by-products obtained from cotton, sorghum, groundnuts, and horticultural crops, an area of 1680 ha will be devoted to forage production in the first phase of the scheme. Four hundred tenants, each with a 4.2-ha tenancy, are expected to benefit from these holdings through the support of about 10,800 head of dairy cattle.[1] Allocation of these animal-production tenancies started in the 1982/83 season and only 73 tenancies were distributed.

Because the scheme area used to be a natural pasture for animals, which were the main investment of the local inhabitants in addition to dry farming, the establishment of the scheme created a nutritional gap in summer for animals in the area. The baseline survey conducted in April 1984 revealed that a summer feeding problem is well recognized by all animal producers. The main reasons sited include the existence of a long dry spell before the rainy season and the prevalence of high prices for fodder substitutes.

The general objective of the multidisciplinary research project jointly sponsored by Canada's International Development Research Centre (IDRC) and the Sudanese University of Gezira (U.G.) is to develop an improved feeding system for dairy cattle on the irrigated Rahad Agricultural Scheme (RAS). To satisfy this goal of helping the farmers in the scheme explore their potential for the improvement of forage production and, consequently, dairy production, a baseline survey was carried out by the team members in April and May 1984. The purpose of the survey was to give an overview of the whole set of problems pertaining to dairy production and to help in identifying priorities for research in this area. The information generated from the survey is thought to be an essential component of the research program. In addition to the above-mentioned survey, several other informal surveys were conducted by the team members. Such information was again very valuable in designing the experiments.

The research team is composed of an agronomist, a plant breeder, an animal scientist, and an agricultural economist. Two types of experiments are conducted concurrently; on-station trials (OST) carried out in the University of Gezira farm in Wad Medani and on-farm trials (OFT) carried out on selected farmers' tenancies in RAS. In this paper, the experience with OFT in the first season in RAS is reported. However, in some instances, information obtained from the baseline survey (1984) and from OST, is referenced.

---

[1] A survey in April 1984, indicated that the average herd size owned by an individual producer is 27 head.

GENERAL AND SPECIFIC OBJECTIVES

The first season for forage production tenancies in RAS was the 1982/83 season. The farmers in the scheme had very little experience in forage production and organized dairy-production systems. In addition, very little research has been conducted to cover cropping systems, seasonality of crops, and improvement of dairy-production systems.

Therefore, the main objective behind conducting OFT in RAS is to familiarize the farmers with appropriate alternatives for efficient production practices without being too far from the realities of the already existing system. The OFT are there to familiarize the researcher with the factors affecting farmers' decisions on whether to accept or reject new approaches suggested from outside the system.

The specific objectives of the OFT in the first season can be summarized as follows:

(a) To follow up and evaluate farmers' management practices in forage production, identify the various inputs available to them, and to record the timing of the different agronomic practices and the yields of the different crops given the farmers' own cultural practices;

(b) To monitor utilization of crops by the animals as to how and when;

(c) To estimate animals' feed intake;

(d) To collect information about milk yield and quality and to evaluate the efficiency of production;

(e) To assess farmers' reactions to the approach, their willingness to adopt new practices, or adherence to traditional practices; and

(f) To get feed-back from the farmers that could help the team members design future experiments and, hence, suggest new approaches that are compatible with the current system.

MATERIALS AND METHODS

Each animal-production tenancy occupies an area of 4.2 ha purposely allotted for forage production. The allotment criteria set by the administration of the scheme emphasized the possession of at least 10 cows out of which seven should be lactating. Also, applicants should not have any other crop or horticultural tenancy registered under their names.

In the first year, five farmers were identified to participate in the OFT. Three farmers were selected for the evaluation of forage yields and the other two were considered for both evaluations of forage and milk production. All five farmers were from village 27, which is one of three villages where forage tenancies have been distributed. Village 27 is favoured over the others because of the relative experience acquired by the 19 tenants in forage production. The 1984/85 season is their third production season.

Selection of Farmers

From three informal visits paid by the team members to the tenants during the 1983/84 season and based on the results of the baseline survey, the team members are impressed by the fact that most, if not all, of the farmers in the area are very excited about the experience of forage and dairy production. They were very willing to work with the research team because they felt that if they were cooperative they might reap some benefits such as: (a) additional land to support more cattle than allowed by RAS; (b) more frequent waterings especially during periods of water shortage; (c) free supply of additional inputs not commonly affordable, such as fertilizers, pesticides, certified seeds, and seeds of newly introduced forage crops; and (d) technical advice by the team members.

This is especially true because the dairy field inspector, the RAS administrator in charge of these tenancies, was involved in both the selection process and supervision of the experiments. In this respect, RAS is a typical, publicly administered production system. The land is owned by the scheme representing the Government of Sudan and it is leased to the farmers. By the tenancy contract, the RAS allocates the land for the farmer, specifies the types of crops to be grown (forages in this case) with the cropping systems and the husbandry practices supervised by the field inspector. Watering is strictly controlled by the scheme. However, the farmer is allowed some flexibility in the choice of cultivars and timing and methods of cultivation. Except for selling the forage from his land, the farmer is free to use his forage as he likes.

The three farmers on whose tenancies forage yields were to be evaluated were selected at random given the fact that most of the farmers were interested and showed a willingness to cooperate with the team members. It was the belief of the team members that taking daily milk-production data in an OFT needs a special kind of farmer. He has to be willing to cooperate and have the patience to continue receiving daily visits by the team members for a period of about 2 weeks. Because of this, the selection of the two farmers on whose tenancies both forage and milk yields were to be monitored was done very carefully. Following interviews with the farmers, the whole plan of work was discussed. The two farmers selected from the volunteers showed a strong commitment to perform the experiments as advised by the researchers. No modification of the farmers' practices was attempted at this time. The trust the farmers had in the research team, established through personal contact, reflected their commitment in the program. This was to the extent that the idea of compensation or incentive was unacceptable to the farmer, at least at this level.

Trial Design

The major forage crops grown in the area are the forage sorghum cultivar Abu 70 (Sorghum bicolor) and local cultivars of lablab beans or lubia (Dolicus lablab). The cultivar Pioneer 988 is a hybrid forage sorghum from Pioneer seed company (USA). It was introduced in RAS last season mainly because many of the farmers did not find enough seeds of Abu 70 in the market.

For the first year of OFT, the three tenancies where forage production was to be monitored were divided into four blocks, each of 1.04 ha. On each of three blocks one crop was grown (Abu 70, Pioneer, and lablab beans). The fourth block was left fallow.

The 1.04 ha of lablab in each tenancy was sown during the first week of August 1984 with local cultivars of lablab at a seed rate of 30-40 kg/ha. Planting was in ridges 70 cm apart with 50-cm spacing between holes along the ridge. Watering was at intervals of 10-14 days. No nitrogen fertilizer was added. The beans started flowering around late November and by the end of December and early January 1985 the pods were almost mature. Cattle started grazing in mid-January. By early January (1985), when the pods were mature, the plants should have translocated much of the dry matter from the foliage to the pods. This may significantly reduce both forage yield and quality.

The farmers were not very much worried about this practice. They still prefer to wait until the pods are mature because they need to collect them for their own food. In addition, seeds are somewhat expensive in the market, so a farmer prefers to produce his own seeds for next season whenever possible. As a result, he is ready to sacrifice the loss in forage yield but compensates for it by the savings he makes in stocking food and seeds for the following season.

The two forage sorghum cultivars were sown during the first week of July 1984 with 30-40 kg/ha of seeds in ridges 70 cm apart. Watering was at intervals of 10-14 days. The first cut of Pioneer 988 was around 1 September. The three farmers claimed that each of the 1.04 ha of Abu 70 and Pioneer 988 sustained the herd for a period of 30 days. The herd sizes ranged between 20 and 30 head. The second crop of Pioneer was grazed around late October and it was ready for the third grazing by early December. However, until the last week of December, it was not grazed and was drying out and infested with aphids. When farmers were questioned about this delay in forage utilization they said that they knew that the perfect time for grazing had already passed but at that time they had enough feed for their animals from open pasture outside the scheme, groundnut residues, sorghum stalks, and chaff and cotton residues inside the scheme. So they prefer to postpone the Pioneer grazing until other sources of feed that will not be available later are exhausted.

Estimation of Forage Yield from the First Crop of Lablab Beans

An estimate of plant population in each of the 1.04 ha of lablab beans in the three tenancies was made by counting the number of plant holes along two randomly selected ridges. Ten metres along each ridge were collected. The counting started at least 5 m from the edge of the block. Then, 10 randomly selected plant holes were dug out and the aboveground matter was weighed. The average weight of the 10 plant holes was multiplied by the total plant population in the block to give the total forage yield in the 1.04-ha block. This method was compared with another method where a transverse section in the middle of the field with a width of 2 m was cut and weighed. From this, the total yield of green forage was also calculated. The two methods gave comparable yield estimates. Because the second method needed more effort and labour in cutting and transporting large quantities of green forage for weighing, besides depriving the farmer of a great portion of the crop, it was thought better to rely on the first method. A second estimate for the green forage left after grazing was made to obtain the amount of fodder consumed by the herd. This was done using the first method of estimation.

Estimation of Yield from the Third Crop of Pioneer 988

Three samples of 2 m along randomly selected ridges were cut about 10 cm from the ground. The weight of the samples was used to calculate the total forage yield in the Pioneer block. A general scanning of the field was made for possible empty spots. When observed, the proportion of the total area they represent was considered in the calculations of the final yield.

Animal Performance Data

Several measurements concerning animal performance were made over the grazing period. Information about milk yield and production, liveweight of cows, and proximate anlaysis of forages, supplements, and digestibility was collected.

Milk Yield and Production

Daily milk yield was measured in custom-made tin cans. Measurements were taken by the team members every other day. On the alternate days, milk yield was estimated by the farmers using their own buckets. The data recorded by the farmers were checked and adjusted. This agreement served the dual purpose of saving important research resources and, at the same time, added to the level of farmer participation in the trial.

Total milk yield per cow is defined as the amount of milk drawn plus the amount left for the calf. The physical presence of calves is a must for milk letdown. An implication of this practice is that calves are not weaned until the cow is dry. The amount of milk left for calves depends on their age. Usually, one or two quarters of the udder are left for the young calf while half a quarter is the amount left for older ones. Based on the assumption that all quarters produce the same amount of milk, the amount of milk drawn from other quarters was measured and the amount left for the calves was estimated.

Milk yield per herd per day was then calculated. Total milk yield per hectare was estimated by dividing total milk yield by the area grazed by lactating cows.

Liveweight of Cows

Cow weight gain was estimated as the difference between liveweight at the beginning and end of the experiment. Liveweight was estimated using a regression equation developed from data obtained at the U.G. farm for the same local breeds: weight (kg) = -592.6 + 5.95 (heart girth (cm)); $r^2 = 0.80$.

Proximate Analysis of Forages, Supplements, and Digestibility

Samples of forages were taken from each farm and were analyzed for moisture, crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), ash, and ether extract (EE) following standard procedures (AOAC 1965). A representative forage sample was taken for digestibility trials in the U.G. farm. Four male desert sheep, 1 year old and of similar body weight, were used in the experiment.

After a preliminary period of 7 days and a 1-week collection period, composite feed and feces samples were analyzed and digestibility coefficients were determined. Total digestible nutrients (TDN) were calculated. The chemical composition of the supplement (sesame cake) was also determined and its TDN was calculated.

Cow requirements were estimated using National Research Council (NRC) guidelines for requirements of dairy cattle. Information on weight, daily milk yield, percentage fat, gain in weight, and nutrient intake were then compared with the NRC requirements to test the efficiency of the farmer's feeding system.

RESULTS AND DISCUSSIONS

It is obvious that the number of farmers on whose tenancies OFTs were carried out is too small, thus allowing no statistical analysis of the data. Nevertheless, this small sample gave a good representation of the patterns of production in the area and served the purpose of familiarizing the research team with the dairy-production system in RAS.

There were observable differences between the farmers' forage yields (Table 1). In this table yields of the three tenancies of lablab and Pioneer 988 were compared with the yield obtained in on-station trials (OST). The station lablab results were better than those of the farmers, whereas their Pioneer gave higher yields than Abu 70 grown at the station level.

The major reason for the differences in lablab yield rests on the low seed rates used by the farmers (30-40 kg/ha) compared with 60 kg/ha for OST. Farmers' blocks in OFT were infested with aphids and OST plots were harvested at a more appropriate time than those of the farmers. It is therefore, considered important to demonstrate the value of both increasing seed rate and chemical control of aphids on yield of

Table 1. Fresh weight of Pioneer (third cut) and lablab beans in RAS 1984/85 (t/ha).

Farmer no.	Lablab beans	Pioneer
3	4.588	16.793
4	6.543	16.094
5	5.988	13.852
Average farmers' yield	5.700	15.580
Average on-station trial (OST) yield	7.000	7.50[a]

[a] Yield of Abu 70.

lablab beans. This will be included in next season's OFT.

It could also be noted from Table 2 that forages are not utilized efficiently given the fact that farmers are letting their animals directly graze the crop. More than 2 t/ha are left as waste after grazing compared to the cut-and-carry practice. The farmer prefers to take his animals to graze the farm for the simple reason that he doesn't have means to transport the fodder from the farm to the animal enclosures in the village. Besides, animals can drink water from the irrigation canals in the farm. Thus, farmers make some savings in both time and money by not cutting the forage. Another disadvantage of the direct grazing practice is that eventually animals cause soil compaction. We would like to make an arrangement with the farmer next season whereby forages are cut and put aside on a small portion of his land where animals can feed on it. This will ensure efficient utilization of the fodder, reduce animal tampering on the land, and may give the farmers more control over the amount to be grazed by the herd for a given time period.

Table 2. Yield of lablab and intake by cattle on two farms.

	Farmer 1	Farmer 2
Total area cultivated (ha)	1.050	1.050
Forage yield/ha (t)	6.721	15.238
Total forage produced (t)	7.058	16.000
Amount ungrazed (t)	2.990	4.727
Amount grazed (t)	4.068	11.275
Dry matter consumed (t)	2.034	3.382
Grazing animals	19	19
Grazing days	11	15
Dry matter intake per cow per day	9.73	11.87
Sesame cake consumed per cow per day (kg, dry matter)	0.90	0.67

Overall, farmers had good yield out of their land. However, they may further improve their yield by taking two extra measures that we hope to demonstrate next season. First, fertilizer application after each cut and, second, insecticide application to control the maize aphid, which is affecting both yield and quality of the forage especially during the cooler months of the year.

The baseline survey indicated that the farmers are not following any specific feeding strategy. This was confirmed by the results obtained with the two farmers. Farmers are supplementing lablab (a high protein forage) with sesame cake (a high protein supplement). This results in protein overfeeding at the expense of energy requirements. As a consequence, cows were found eating more dry matter than what they really needed; possibly trying to make up for the

Table 3. Proximate composition of forage and supplement.

	% on dry matter (DM) basis[a]					
	CP	EE	CF	NFE	ASH	TDN
Lablab						
Farmer 1	14.8	1.6	26.6	47.0	10.0	51.0
Farmer 2	14.0	2.0	30.7	43.2	9.9	52.0
Sesame cake	41.0	12.7	9.5	22.0	14.9	8.5

[a] CP = crude protein, EE = ether extract, CF = crude fibre, NFE = nitrogen-free extract, TDN = total digestible nutrients.

energy deficiency. These results are presented in Tables 2-4. These findings suggest that a feeding system that is geared toward more judicial feeding of forages supplemented with the appropriate concentrate(s), even with the current inputs, is expected to improve the productivity of the milking herd. It is worth noting that the supplements are given to the cows regardless of the amount of milk produced, stage of lactation, or the physiological status of the cow (pregnant or not). Instead, the amounts fed depended on the type of available roughages. More quantities of supplements are given when the herd is put on sorghum straw. The farmers are not dependent exclusively on the farm for feeding. The herd is taken outside the scheme to graze open pastures and to other fields to graze crop residues. The area is insufficient to sustain the actual number of animals owned.

The first farmer seems to have a better genetic potential in his herd. In fact, he sets a standard that any cow that produces less than 3.6 kg/day will not be kept in the herd (Tables 5 and 6). He culls his cattle continuously, whereas the second farmer pays no

Table 4. Nutrient intake/day compared to NRC established requirements (kg).

	Farmer 1			Farmer 2		
	DM[a]	CP	TDN	DM	CP	TDN
Daily intake						
Forage	9.730	1.440	4.962	11.870	1.662	6.172
Cake	0.900	0.360	0.765	0.670	0.275	0.342
Total	10.630	1.800	5.727	12.540	1.937	6.514
NRC requirements						
Maintenance		0.373	3.150		0.375	3.150
Production		0.596	2.180		0.472	1.760
Gain		0.500	2.260		0.400	2.260
Total	8.630	1.469	7.590	8.540	1.247	7.170
Total intake - total requirement	2.000	0.331	-1.863	4.000	0.690	-0.656

[a] DM = dry matter, CP = crude protein, TDN = total digestible nutrients.

Table 5. Herd structure (head).

	Farmer 1	Farmer 2
Lactating cows	10	12
1st lactation	1	6
2nd lactation	7	3
3rd lactation	1	1
4th lactation	1	1
5th lactation	-	1
Pregnant cows	9	6
Bulls	-	1
Calves		
Females	4	3
Males	6	9

Table 6. Milk production data.

	Farmer 1	Farmer 2
Lactating cows	10	12
Herd average/day (kg)[a]	43.11	36.31
Average milk yield per cow per day (kg)	4.4	2.91
Milk fat (g/kg)	43	53
Milk protein (g/kg)	32.7	34.1
Total milk per herd per day (kg) (herd average + amount left for calves)	64.3	59
Total milk yield per ha (kg)	1284.96	1607.86

[a] Does not include amount left for calves.

attention to the amount of milk produced and tends to keep the cow that produces a calf each year.

The team discussed with farmer no. 1 the idea of milking his cows twice instead of the common practice of once a day. He was approached because it was thought that he had good potential in his herd. He was not very interested in the idea for two reasons: first, it is difficult for him to move the herd twice a day between the village (for milking) and the farm (for grazing); second, milking twice means more milk for which there is no market in the neighbourhood. Six other farmers were questioned about this and it was clear that there is a marketing problem for the fresh milk. Ironically, there is a high demand for both fresh milk and cheese in the neighbouring towns, but they are not accessible to the donkey retailers on whom the farmers depend for the marketing of the milk. This necessitates a closer look into the problem to see the possibility of establishing an efficient milk-marketing system.

FUTURE DIRECTIONS

The first year of OFT has been a learning experience for the research team in helping them to gain a better understanding of the farming system. Based on the experience gathered in the preliminary OFT, which involved only five farmers, the approach to OFT for next season will take into consideration the farmers' reactions to the first year of OFT. It will attempt to address problems that require the minimum disturbance to the farming system. Further specific surveys will be conducted to address mainly the particularities of livestock feeding and management practices. A larger number of farmers from the three villages will be involved in the second year of OFT. With the problems encountered during the first year OFT and surveys taken into consideration, the OST will continue to screen alternatives for improving crop and livestock management.

Acknowledgments

The authors would like to acknowledge the hard work and the great efforts of Ilham A/Rahman, Abdalla

El Tayeb, and Omer El Hafian in conducting the chemical analysis.

REFERENCES

AOAC (Association of Official Analytical Chemists). 1965. Official Methods of Analysis of the Association of Official Analytical Chemists, 12th ed. Washington, DC, USA, AOAC.

AOAD (Arab Organization for Agricultural Development). 1983. Feasibility study for the improvement of milk production and marketing in Dueim Area, D.R. Sudan. Sudan, AOAD. (In Arabic)

NRC (National Research Council). 1975. Nutrient requirements of dairy cattle. Washington, DC, USA, National Research Council.

ON-FARM TRIALS IN NORTHWESTERN SYRIA: TESTING THE FEASIBILITY OF ANNUAL FORAGE LEGUMES AS GRAZING AND CONSERVED FEED

Dennis Tully,[1] Euan F. Thomson,[2] Ronald Jaubert,[1]
and Thomas L. Nordblom[1]

[1]Farming Systems Program, and [2]Pasture, Forage and
Livestock Program, International Center for Agricultural
Research in the Dry Areas (ICARDA), P.O. Box 5466
Aleppo, Syria

Abstract *In areas of Syria receiving 200-350 mm annual precipitation, barley is the main crop and is grown continuously or alternated with fallow. Only small areas of forage legumes such as vetch (Vicia sativa) and lathyrus (Lathyrus sativus) are sown due to poor yields and high costs of both seed and harvest labour. Two sets of trials were designed to quantify yield potentials, costs, and constraints for rotations involving forage legumes either for spring grazing or harvested at maturity to provide conserved winter feed.*

Grazing trials were established on eight farms to compare vetch (1 ha) and lathyrus (1 ha) for lactating ewes. Farmers' flocks were divided into three matched groups and assigned to the two forage crops and to a "control" group grazing communal pastures. Milk production and ewe liveweights were measured regularly with farmers' assistance. Complementary rotation trials and surveys were continued in the area.

Harvest trials with 0.5 ha vetch and 0.5 ha lathyrus were established on each of 12 farms. The farmers' labour needs and costs of harvesting were monitored. Nested within each harvest trial were rotational plots (0.2 ha) designed to quantify responses of fertilizer treatments on lathyrus, vetch, lentils, barley, barley plus nitrogen, and to trace the effects on a barley crop sown the following year.

Résumé *Dans les régions de la Syrie où la pluviosité atteint 200 à 350 mm par année, l'orge est la culture principale et elle est cultivée de manière continue ou en alternance avec une période de jachère. Parce que les rendements sont faibles et que les coûts des semences et de la main-d'oeuvre pour la moisson sont très élevés, on ne sème que de petites zones de légumineuses fourragères telles que la vesce (Vicia sativa) et la gesse (Lathyrus sativus). Deux séries d'essais ont été préparées en vue d'évaluer le potentiel de rendement, les coûts et les obstacles à la rotation des légumineuses fourragères qui donneraient des pâturages du printemps ou, si elles étaient récoltées à maturité, un fourrage d'hiver sec.*

On a donc constitué des pâturages expérimentaux dans 8 exploitations afin de comparer les effets de la vesce (1 ha) et de la gesse (1 ha) sur les brebis qui allaitent. Les troupeaux des exploitants ont été divisés en trois groupes assortis; aux deux premiers, on a assigné les 2 cultures fourragères et au troisième, le groupe témoin, des pâturages communaux. La production de lait et le poids des brebis sur pied ont été mesurés régulièrement avec l'aide des propriétaires. On a poursuivi, dans le secteur, les rotations à l'essai et les enquêtes.

Dans chacune des 12 exploitations, on a constitué des cultures expérimentales de 0,5 ha de vesce et de 0,5 ha de gesse. On a observé les besoins en main-d'oeuvre des agriculteurs et les coûts de la moisson. Dans chaque lot expérimental on a réservé des parcelles à la rotation (0,2 ha) en vue d'analyser, d'une part, la réaction à la fertilisation par engrais de la gesse, de la vesce, des lentilles, de l'orge, de l'orge azoté; d'autre part, de déceler les effets de la fertilisation sur de l'orge semée l'année suivante.

In the dry cultivated areas of Syria, the primary agricultural activity of the rural population is barley production integrated with raising sheep. The predominant crop rotation is cereal/fallow, but a secondary practice is continuous or nearly continuous cereal cultivation. Total agricultural output of both systems may be improved by using alternative crop rotations in which forage legumes replace fallow or act as a break crop in continuous cereal cultivation, inhibiting disease and contributing to soil fertility. In addition, forage

legumes with good productivity in dry conditions could contribute to the supply of livestock feed.

Syria, like much of the Mediterranean area, is characterized by a sharp rainfall gradient, with high rains in mountainous areas near the sea, giving way to steppe and eventually desert further inland. The high rainfall areas are associated with intensive cultivation of wheat, legumes, summer crops, and tree crops, whereas much of the steppe is permanent grazing land. Between these areas lie the dry cultivated areas of Syria, where average rainfall is between 200 and 350 mm. Soils are basic, usually limestone or basaltic, in origin and frequently low in available phosphate (FSP 1982, p. 26; Harmsen 1984). Many are also shallow or stony, which are characteristics that are associated with poor crop yields (Matar 1984).

The research reported here is taking place in this transition area, where barley is the major crop, grown almost entirely as feed for sheep and goats. Sheep are a major source of income as well as products for family consumption. However, they can be costly to maintain. Feed shortages are common, and purchase of feed produced outside the system is necessary, imposing a strain on the limited cash resources of farmers. The variable productivity of both agriculture and communal grazing areas within the cultivated zone exacerbates the feed problem. In addition, both arable land and grazing areas are being exploited through management practices that may lead to soil degradation and further declines in output.

Survey work has shown both cereal/fallow and continuous cereal to be the most common rotations in areas with less than 300 mm average annual rainfall, and also on poor soils in wetter zones (FSP 1982; Tully 1984). Experiments at the International Center for Agricultural Research in the Dry Areas (ICARDA) research stations, as well as on-farm, have indicated that alternative rotations, including forage legumes such as vetch, lathyrus, and peas, (_Vicia sativa_, _Lathyrus sativus_, and _Pisum sativum_, respectively) are agronomically feasible in dry areas (ICARDA 1984). However, survey research and economic analysis (Tully 1984; Jaubert and Oglah 1985) indicate several problems limiting the area planted to legume crops. These include low profitability, due primarily to low yields and high harvest labour costs, and the fact that the forage legumes have to compete as feed with both communal grazing and inexpensive agroindustrial by-products. Thus, their economic feasibility and overall attractiveness to farmers require additional testing, and on-farm trials play a major role in this respect.

Even if analysis of data from the research station using local market prices indicates that profitable forage legume crops can be grown, several questions remain concerning their feasibility and impact. Can acceptable and sustainable yields be achieved in the diverse soil and climatic conditions faced by farmers? Do farmers have the cash and labour resources to invest in legume rotations? Can the crop produced be put to profitable use in a semisubsistence farming system? What unexpected factors might inhibit the adoption of rotations including legumes? These questions are addressed in on-farm trials as well as associated survey research.

The agronomic aspect of rotations with legumes is being addressed in two sets of factorial trials in farmers' fields, which measure on-farm yields of legumes under a variety of treatments, and their effect on a subsequent cereal crop. The economic aspect is somewhat more complex because the crop may be used in more than one way. Specifically, two main options for using forage legume crops are being tested on-farm: grazing the crop before maturity, and harvesting the mature crop for grain and straw.[1] Yield measurements will also be taken before pod maturity to test the potential of the crop as hay. However, due to dry matter losses incurred in making hay (ICARDA 1984, p. 223; Osman and Thomson 1985), as well as the labour costs and lack of seed production, this form of conservation is not considered suitable for on-farm testing at this time.

The relative merits of these alternative crop uses partly depend upon the livestock feeding system. In most of the barley-growing area, sheep feed sources vary over the course of the year. The following description of the feeding cycle is based on previous survey research (FSRP 1980; Nygaard et al. 1982; Tully 1984; Jaubert and Oglah 1985; Jaubert and Thomson 1985).

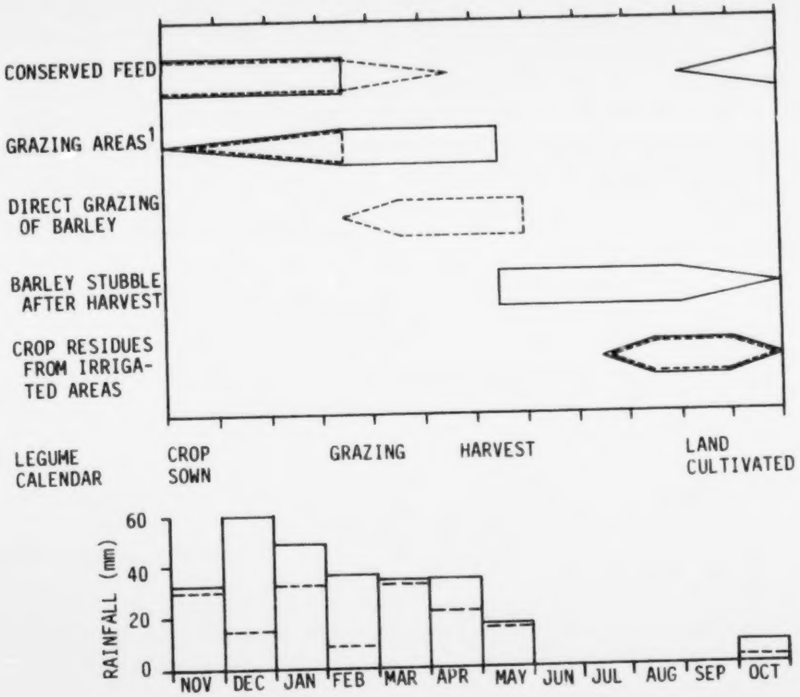
---

[1] The term "straw" is used throughout this report for crop residues after threshing and separation of the grain. It includes chopped leaves, stems, and chaff.

In winter, animals are usually confined to the village during the early rains and planting season, i.e., November/December. At this time, most animals are largely dependent on stored or purchased feeds, such as barley grain and straw, cottonseed cake, sugar beet pulp, and legume straw. Most lambing takes place in December and January. At some time between January and March, grazing becomes available in the steppe and on local communal grazing areas, and may continue to be available throughout the summer. Many sheep are taken to the steppe. Feeding is reduced or halted if the season is good but must continue in a dry year. Some immature barley is grazed by lambs and, in the driest years, large areas of crops may be grazed off at this time. Milk production reaches a peak in spring, providing about 25% of the cash income from keeping sheep.

Harvesting takes place in May or June. At this time, sheep are brought back from the steppe to graze crop residues. Also, crops are sometimes more profitably grazed than harvested (Nordblom 1983). Stubbles, standing crops, and grazing lands support the animals until autumn. Some animals also graze irrigated crop residues, both locally and in other parts of the country. As winter approaches, livestock become increasingly dependent on supplementary feed until they are again confined to the village (Fig. 1).

The production of a new livestock feed must be considered in terms of its place in this cycle. Harvesting and threshing an annual forage legume provides a feed that can be used in winter, at a time when animals are almost entirely dependent upon purchased or stored feedstuffs. According to farmers, this is the season of greatest feed shortage. However, because these crops must be harvested by hand within a very brief period, the availability and cost of labour is expected to be a major constraint.



[1] Village based flocks utilize local marginal grazing areas. Transhumant flocks move to steppe land in spring for grazing.

Solid lines represent normal practices; dotted lines represent practices observed in a particularly dry year.

Fig. 1. Livestock feeding cycle at Bueda.

One way to avoid the harvest labour problem is to graze the crop in spring. At this time animals subsist primarily upon communal resources: grazing lands, fallow land, and the steppe. There is evidence that the steppe and communal grazing land are being degraded by overuse; thus, provision of alternative feed can have an important conservation effect. However, direct grazing of forage crops has certain economic disadvantages. In particular, the communal grazing resources are seen as free goods. At the farm level, the costs and benefits of producing an alternative to them may not be favourable. Therefore, grazing trials are being undertaken to determine whether the production of forage legumes for grazing can be economically feasible from the individual farmer's point of view. Some combination of grazing and harvesting the forage crop may be an optimal strategy.

To quantify the returns to alternative uses of forage legume crops, two sets of large-plot trials are under way this year. In one set, large areas of vetch and lathyrus will be harvested by farmers. The amount, source, and cost of labour used will be closely monitored, as will the use to which the crop is put. Presumably, most farmers will use the crop as winter feed. Farmer opinions will be periodically collected. In the other set, large areas of vetch and lathyrus will be subjected to controlled grazing in spring. The productivity of animals grazing crops will be compared with those grazing communal areas. Both sets of trials are associated with small factorial agronomic trials.

This paper focuses on the current year's trials, which are the largest and most complex in overall design of any we have yet attempted. However, we have learned a great deal from smaller on-farm trials in the previous two seasons, and these lessons have helped us design the current set (ICARDA 1984; Thomson 1984; Jaubert et al. 1985). The 1982/83 grazing trial with lambs obtained good liveweight gains on vetch pasture. In the 1983/84 trials, the value of increased milk production appeared to cover the cost of planting the forage crop, even though the season was very dry. The trials also revealed some problems in the cultivation and palatability of peas, a farmer preference for lathyrus as feed, and a good phosphate response by all legume crops even in dry conditions. In addition, these trials have taught us many lessons about logistics and trial design, which will be expressed in what follows. Furthermore, through these trials we have earned the confidence and friendship of cooperating farmers who have been indispensable in expanding the grazing trials this season.

MATERIALS AND METHODS

Identification of Locations and Farmers

In on-farm trials generally, and with large plots in particular, it is logistically difficult to have replication within an experimental plot. Excessive complexity also reduces the usefulness of trials for the elicitation of farmers' observations on the treatments tested. In the case of farmer-managed or joint-managed trials, where the farmer's practices or opinions are essential concerns of the trial, replication within one farmer's field does not increase our information about his or her reactions. Thus, on-farm trials are usually conducted with several farmers at each location to replicate the experiment. This implies a two-stage selection procedure: selection of research locations and selection of farmers.

In the currently reported research, several farmers were selected in each of a total of five locations. Large-plot grazing trials are taking place at one location with six farmers and another with two farmers; at the latter location, yield trials of similar design are also taking place on five smaller fields. A more complex agronomic trial in combination with a large-plot harvest labour trial is taking place at three other locations with four farmers at each location.

Selection of Locations

Research locations were chosen to represent different ecological, farming, and livestock-management systems and to build upon earlier research (Fig. 2). In the Breda area, rotation research at a nearby ICARDA station in combination with survey research in the area led to a concentration of three sites. Two grazing trial locations were selected, one with access to communal grazing and one with limited access. A third site was selected for a harvest labour trial. Villages were selected with farming practices typical of the area, i.e., barley grown with few inputs as the predominant crop and sheep products as the main output (barley-livestock system). Accessibility of the villages by vehicle was also necessary.

Two research sites were also selected in Al Bab for comparison with the Breda area, building upon

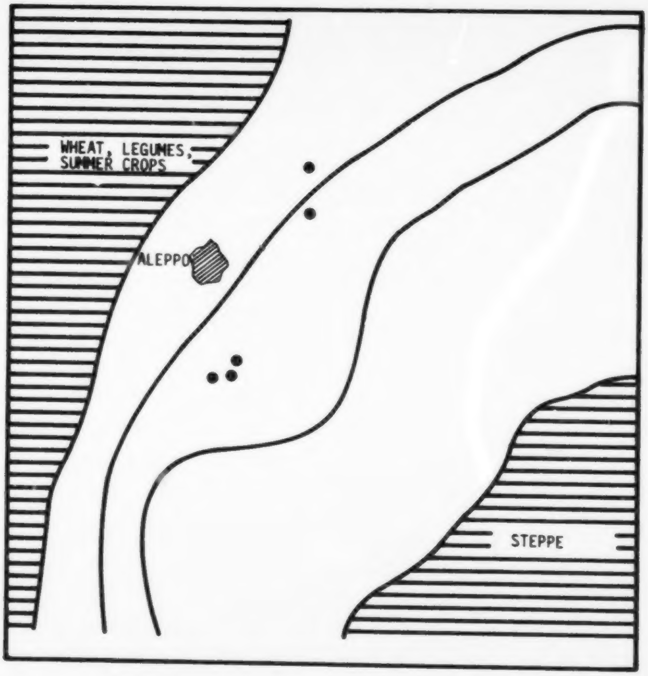


Fig. 2. Location of livestock on-farm trial sites.

previous survey research (Tully 1984). One village was chosen to represent a relatively high-rainfall (≥300 mm) area, in which the shallow soils are usually planted in a cereal-fallow rotation. Therefore, trials in this site are located on shallow soils. The second location represents a slightly drier area of Al Bab. As a first step in this area it was decided to attempt cultivation on average or better-quality soils.

Selection of Farmers

Ideally, if farmer management and opinions play a significant role in the trial objectives, one would like to have a large number of randomly selected farmers. In practice, the number of trial farmers is small, and the number of basic requirements for inclusion in the trials is large. There is a trade-off between getting cooperative and accessible farmers and getting a representative sample. Although one can exclude obviously unusual farmers, one must be cautious in generalizing to the whole rural population from the results of trials with a few purposefully selected farmers. One remedy for this is associated survey work with proper sampling techniques to assess the applicability of trial results to other farmers.

In new research locations, it was necessary to work with the village representative or the head of the cooperative to find suitable farmers with appropriate fields. In the locations with grazing trials, survey work and other trials have taken place before, and potentially cooperative farmers were known to researchers or recommended by neighbours. This was particularly important in the case of the grazing trials, which require substantial alteration in the farmers' management of their own resources; a good deal of trust was required.

The following basic factors were used in selecting farmers and fields: (a) cooperative and interested farmer; (b) one field from each farmer; (c) a responsible adult family member expected to be resident during trial; (d) no exceptional farmers (big landowners, college graduates); (e) no closely related farmers; (f) ownership of at least 21 breeding ewes for grazing trial; (g) suitable soil type; (h) previous crop cereal; (i) typical cultivation and fertilization history; (j) accessible by vehicle; (k) minimum size 1.2 ha for harvest trial, 2 ha for grazing trial; (l) minimum width 48 m wide for harvest trial, 20 m for grazing; (m) fields not too close together; and (n) safe from accidental grazing.

Although most requirements were absolute, some exceptions were made in criteria (e), (f), (k), and (l). In one area in which land is owned in narrow strips, a field width of 14 m was accepted in one case (which produced a trial field 850 m long!). Two other farmers with insufficient sheep for the grazing trial, but otherwise ideal conditions, were loaned sheep from the ICARDA flock. Another farmer with a field slightly too small for the grazing trial will be using flocks of five sheep instead of six. It is often necessary to be flexible on logistical points that do not compromise the value of the results.

Trial Design

The trials include two sets of rotation trials, large-plot grazing trials, and large-plot harvest labour trials. Both agronomic output and actual or potential livestock productivity are estimated in all trials. Thus, agronomic yields are measured in grazing trials, whereas nutritional measures are made in harvest trials. Combining livestock and agronomic measures in the design increases the yield of information at little increase in cost.

Land preparation and planting are done with local equipment and techniques. The land is ridged using a ducksfoot cultivator fitted to a local tractor. Seed and fertilizer are broadcast over the ridges by a local farmer and covered by splitting the ridges with the same cultivator.

Designs are generally split-plot with randomization of main plots. Farms serve as replicates. Details are summarized in Table 1 and subsequent figures. The complex agronomic trial (Fig. 3) represents the first year of a 2-year rotational trial. Six rotations are compared: barley following vetch, lathyrus, lentils, barley, barley with nitrogen, and fallow. Each main plot is split by phosphate and carbofuran treatments (with or without).[2] In the first year, treatments and species will be compared for their feed productivity. In the second year, all plots will be planted with barley to measure their effect on subsequent crops, with and without additional phosphate. Thus, this trial will examine the agronomic feasibility of introducing rotations with forage legumes and their ability to compete economically with several existing rotations.

The complex rotation trials are carried out on relatively small plots (albeit larger than the usual

---

[2] The latter treatment is included, in combination with monitoring of nodule damage and biological nitrogen fixation by the legumes, to diagnose the effect of sitona weevil on forage legumes in this area; these insects are an endemic pest on lentils in neighbouring areas (Tahhan and Hariri 1982).

Table 1. Details of trial designs.

Complex rotation trials

Treatments compared

Six rotations: Lathyrus, vetch, lentils, barley, barley + N, fallow, followed by barley
+/- P_2O_5 (46 kg/ha)
+/- Carbofuran (30 kg/ha)

Factors held constant

Legume seed rate (150 kg/ha)
Barley seed rate (100 kg/ha)
Uniform inoculation

Trial size: 0.2 ha (24 plots x 80 m^2)
Replication: Four replicates in each of three locations

Simple rotation trials

Treatments compared

Four rotations: Lathyrus, vetch, peas, and fallow followed by barley
+/- P_2O_5 (50 kg/ha) on crops only

Factors held constant

Legume seed rate (180 kg/ha)
No inoculation

Trial size: 0.35 ha (7 plots x 500 m^2)
Replication: Five replicates in one location (plus grazing trials sites)

Grazing trials

Treatments compared

Grazing vetch, lathyrus, and communal rangeland
+/- P_2O_5 (50 kg/ha) on crops; DM yield only

(continued)

Table 1. Concluded.

Factors held constant

Legume seed rate (180 kg/ha)
No inoculation

Trial size: 2 ha (4 plots x 0.5 ha) plus small fallow strip
Replication: Two replicates in one location and six replicates in another

Harvest trial

Treatment compared

Two species (vetch and lathyrus)

Factors held constant

Seed rate 150 kg/ha
46 kg/ha phosphate fertilizer
Uniform inoculation

Trial size: 1 ha (2 plots x 0.5 ha)
Replication: Four replicates in each of 3 locations

---

on-station plots). They receive a relatively high level of scientist management, especially in the layout, planting, and sampling. They are nested within the large-plot harvest trials (Fig. 4), which provide them with a measure of protection.

The simple agronomic rotation trial (Fig. 5) uses fewer treatments and larger plots than the complex rotation trial. It compares the prevailing unfertilized barley/fallow rotation to rotations of barley with vetch, peas, and lathyrus, with and without phosphate. This trial will be planted with uniform unfertilized barley next year to assess the overall economics and agronomics of the rotation. The other phase of this replicated trial, which began in the previous season when the forages were grown, is planted to uniform barley this season.

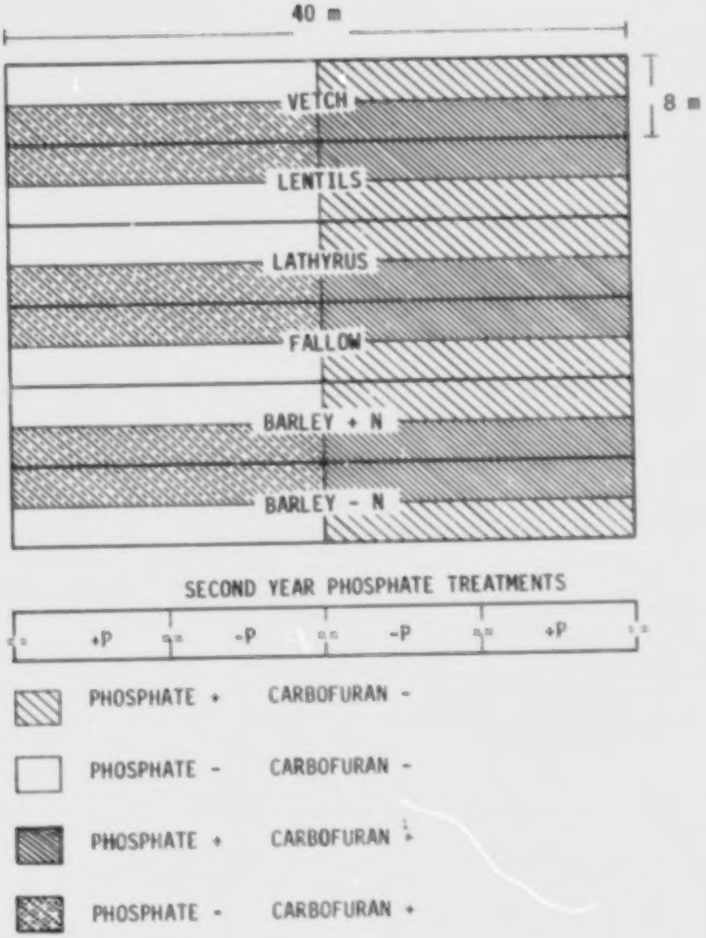

40 m
8 m
VETCH
LENTILS
LATHYRUS
FALLOW
BARLEY + N
BARLEY - N
SECOND YEAR PHOSPHATE TREATMENTS
+P
-P
-P
+P
PHOSPHATE + CARBOFURAN -
PHOSPHATE - CARBOFURAN -
PHOSPHATE + CARBOFURAN +
PHOSPHATE - CARBOFURAN +

Fig. 3. Basic plot layout, complex rotation trial.

The plot design of the grazing trials is based upon the simple agronomy trials, but larger in scale. Lathyrus and vetch are planted on large areas for grazing by trial flocks. Peas are continued in the simple agronomy trial but are absent from the 1984/85 grazing trials, because they have been found to be unpalatable at the green stage (Thomson 1984; Osman 1985). The species will be grazed separately in most cases, although some farmers are unable to commit the management time required. Main plots are further split

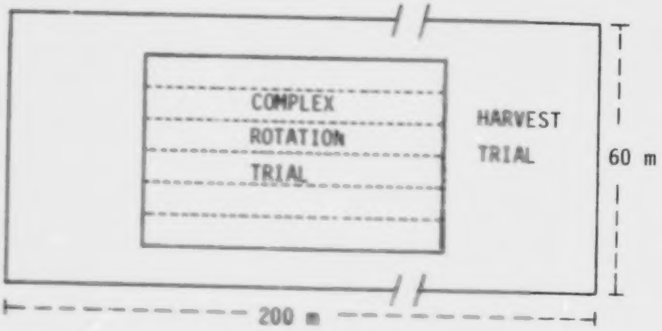

COMPLEX
ROTATION
TRIAL
HARVEST
TRIAL
60 m
200 m

Fig. 4. Typical nested plot layout (harvest trial).

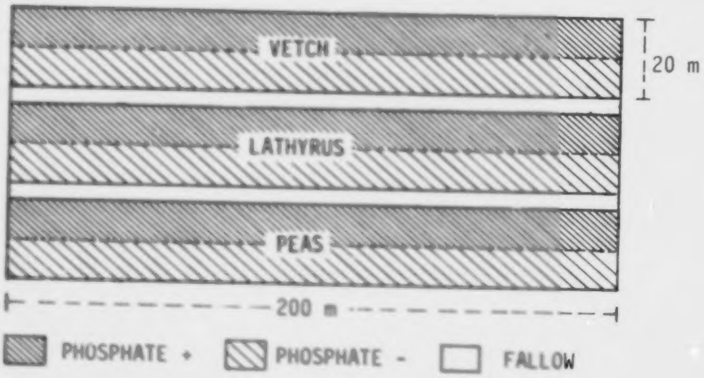

VETCH
LATHYRUS
PEAS
20 m
200 m
PHOSPHATE +
PHOSPHATE -
FALLOW

Fig. 5. Basic plot layout (simple rotation trial).

into areas with and without phosphate for additional measurements of phosphate response; however, it will not be possible to graze these separately because the areas will be too small and an unmanageable number of experimental flocks would be required.

Each flock is divided into experimental flocks, which graze the forage crops, and a control flock, which grazes on communal lands under current farmer practice. The productivity of experimental and control flocks will be compared.

Minimal flock size is 21 lactating ewes; six for each treatment and three reserves.[3] Our experience in previous seasons with both lambs and ewes suggested that changes in milk production by ewes were more immediately perceptible to farmers than liveweight gains by lambs. One important difficulty with lactating animals is that they may still be suckling young at the time when the trial should start. It is, therefore, necessary to choose ewes that lambed at least 2 months before grazing is expected to begin. Approximate dates of lambing can be ascertained by visiting sample flocks during the lambing season.

Ewes in experimental and control flocks should be balanced with respect to liveweight, age, stage of lactation, and milk-yield potential. Milk-yield potentials are estimated by measuring milk production during the week before the start of grazing. Milk yield is measured for some time after the trial is completed. If substantial differences between flocks are found under identical conditions, this information can be used to adjust measurements of milk production made during the grazing period.

Stocking rates and plot sizes are based on previous experience in the area. The minimum "social group" of ewes is five or six; if there are fewer animals, they are likely to remain nervous and graze poorly. Thus, plots large enough for six animals are used in all but one case, where flocks of five ewes will be used. In a 1982/83 grazing trial with lambs, a pasture area of 150 m^2/lamb (of 25-35 kg) was exhausted after 18 days (Thomson 1984). In 1983/84, which was very dry, a grazing trial was conducted with ewes of 45-50 kg; 1500 m^2 of vetch per animal lasted 35 days (Jaubert et al. 1985). A similar stocking rate (6 ewes/ha) will be used this year, with the exception that a longer grazing period will be possible in most seasons. Assuming a potential crop yield of 1200 kg of dry matter (DM), which is 70% available, a 1-ha plot should satisfy six sheep eating 2 kg DM daily for 70 days.

---

[3] During selection it is desirable to identify farmers having even more ewes to allow for deaths, barrenness, etc.

During the period before grazing starts, both experimental and control flocks are managed together according to local practices. At least 500 kg DM/ha should be available before grazing starts. Sheep are given access to all the grazing area.

The design of the harvest labour trials is very simple. Plots of 0.5 ha of vetch and lathyrus, with uniform cultivation, seed rate, inoculation, and fertilization treatments, are planted side by side. Harvesting will be managed by the farmer. Labour inputs and costs to the two crops will be compared based on observations and interviews. The farmers' use of the crop and opinions about it will be recorded in follow-up interviews.

Day-to-Day Control of Trials

Field plots intended for harvest require little supervision. Small plots are protected by fencing or by nesting within the larger plots, but harvest plots are, hopefully, safeguarded by the original site selection. It is up to the farmer to protect these plots as much as he chooses. Small plots will be harvested by researchers, but the large plots will be harvested by the farmer at whatever time he chooses. Any weeding or other input to those plots is at his discretion.

As for the grazing trials, farmers are responsible for supervision of sheep. The control flocks are herded by the village shepherds as usual. However, experimental flocks must be moved to and from the correct grazing plots at times determined by researchers. Grazing plots are fenced to ensure that flocks remain on the assigned areas and to keep out stray animals or neighbouring flocks. Fences will be removed once trials are completed; they are not considered an integral part of the technology being tested. Ewes are marked with removable plastic ear tags and spots of dye on the rump. Flocks are mixed at night in sheds or pens. During grazing trials, sheep receive no supplements.

Women milk the ewes as usual before they go to graze in the morning and after returning in late afternoon. Where possible, total milk production is weighed and recorded on a daily basis by a member of the family. These measurements are verified once per week by technicians. The involvement of family members increases their awareness of differences in milk yield between treatments.

On-Farm Measurements

Pasture availability measurements have been taken in all treatments of all agronomic trials in the second week of March. These will be subjected to nutritional analysis to determine their feed value as a grazing crop. The same will be done with samples from mature crops. Standard yield measures will also be taken. In the grazing trials, yield samples will be protected with wire cages, 1.8 m^2, with five cages per treatment.

In complex agronomic trials, biweekly measurements will be made of acetylene reductase activity (a measure of biological nitrogen fixation) and nodule damage. The effect of the various crops and treatments on available soil nitrate and phosphate levels will be evaluated with soil samples taken before the next cropping season.

As mentioned, milk production will be regularly monitored in the grazing trials. The other main component of livestock output is liveweight gain, which is more difficult to monitor frequently in a large sample. Thus, intermediate weighings will be limited to every 28 days. Consecutive weighings on 2 days will be made at the beginning and end of the trials to minimize the effect of short-term fluctuations of rumen fill.

Incentives

In any on-farm trial, farmers incur a certain amount of inconvenience and possibly risk. They may legitimately expect some form of compensation, whether rent or salary, if they are contributing to the trials. On the other hand, farmer attitudes and practices may be biased by unrealistic levels of compensation, whether too high or too low. The form of compensation also may have an effect on the farmers' practices that we observe; for example, if feeding practices are being measured, compensation in the form of barley would be more likely to affect these practices than compensation in wheat (assuming wheat is not being fed to sheep, which is sometimes the case). Thus, careful consideration must be given to the question of incentives to our farmer collaborators.

In this season's trials, it is relevant to contrast the harvest labour trials with the grazing trials in this respect. Arrangements in the harvest labour trial are fairly simple. A small rotation trial (0.2 ha) is nested in the larger trial, made up of 0.5 ha of lathyrus and 0.5 ha of vetch. Researchers provided seed, inoculum, and fertilizer, and hired local broadcasters and tractors for the entire plot. Thus, all initial costs were borne by ICARDA. The average value of inputs provided, not counting inoculum or ICARDA labour, was approximately SDP 700 per 1.2-ha plot (3.9 Syrian Pounds (SDP) = US$1).

The harvest will belong to the farmer. Thus, any effort made by the farm family to weed, guard, or harvest the crop returns the benefit to the family. (So far, no plots have been damaged by grazing.) We only require samples, interviews, and use of the 0.2-ha plot next year for barley cultivation.

In contrast, the grazing trials present farmers with greater demands for their time and labour and require that the farmer put his flock, which may be his major asset, through an unfamiliar feeding practice. Substantial supervision of experimental flocks by the farmer is required. Furthermore, they will not harvest the crop, although their sheep will consume it. As a result, higher levels of compensation are offered to the farmers. All cultivation costs of the crops are borne by the researchers, as before, but additional compensation is provided in the form of 500 kg of wheat per farmer. Two farmers who keep ICARDA sheep for the trial also benefit from the increased availability of milk and wool.

Assessment of Farmer Reactions

In general, two kinds of farmer reactions are of interest: both to having a trial on their land and to the technology being tested itself. These are easily confounded; farmers may feel very positive about the research because they have enjoyed the interaction and the incentives; alternatively, they may wish never to see a forage legume again after being bothered by forage-keen researchers for a season. Fortunately, our problems are usually of the former variety. In follow-up interviews, it is necessary to try to separate these issues with carefully designed questions.

Farmers should also be encouraged to express their thoughts about the trial and the research objectives in unstructured interviews, in which researchers must be open minded and ready for surprises. Many aspects of the current research design - including the species chosen, the crop uses being tested, and the measurements being taken - have grown out of this combination of systematic and open-ended interviewing in previous trials and surveys.

Logistics

The process of on-farm research requires careful planning to make efficient use of research resources. Researchers, technicians, and farmers have to coordinate their activities, and research inputs must be available when they are needed. This is especially true when sites are being used as replicates; for greatest comparability, the sites should be planted within a limited period of time under similar conditions. For these reasons, we have tended to concentrate our livestock on-farm trials (unlike other agronomic or variety trials that require less-intensive management) within easy traveling distance of Aleppo.

Major time inputs to the trials are listed by category in Table 2, and costs are estimated in Table 3. The simple rotation trial has been listed separately from the grazing trial; however, because these trials are close together, trips frequently involve both trials to save time. Because the harvest and complex rotation trials are on the same plots, it was not feasible to separate them; however, it is worth mentioning that most labour for plot layout and periodic measures is accounted for by the rotation trial.

Several points are worthy of mention. Selection time for locations and farmers was fairly low. However, these trials followed upon survey work and previous trials, which made the process much faster than it would have been if started cold. The grazing trials require considerably more trips and technician time than

Table 2. Logistical requirements of on-farm trials.

Research Operations	Grazing trials (2 ha x 8 farms)			Simple rotation (0.6 ha x 5 farms)[a]			Harvest and complex rotation trials (1.2 ha x 12 farms)		
	No. of trips (70 km)	Tech. time (days)	Sci. time (days)	No. of trips (70 km)	Tech. time (days)	Sci. time (days)	No. of trips (80 km)	Tech. time (days)	Sci. time (days)
Selection of locations, farmers, and plots	7	7	7	3	3	3	10	10	10
Plot layout and planting	25	50	13	5	10	2	8	32	8
Fence and cage assembly/removal	32	64	2	7	14	0	-	-	-
Selection and tagging of animals	7	14	7	-	-	-	-	-	-
Periodic measurements and sampling	51	96	15	9	18	1	64	95	25
Follow-up interviews	8	8	8	2	2	1	9	9	9
Total	130	239	52	26	47	7	91	146	52

[a] Includes 0.35 ha of forage crops and 0.25 ha of barley (second year of trial).

Table 3. Input costs of on-farm trials (US$).

	Grazing trials (2 ha x 8 farms)		Simple rotation (0.6 ha x 5 farms)[a]		Harvest and complex rotation trials (1.2 ha x 12 farms)	
	Amount	Approx. cost[b]	Amount	Approx. cost	Amount	Approx. cost
Basic inputs						
Cultivation	16 ha	492	3 ha	98	14.4 ha	307
Seed	2880 kg	1662	420 kg	215	2050 kg	1231
Fertilizer (TSP)	1760 kg	451	96 kg	25	1350 kg	415
Labour for planting and fertilizing		207		46		205
Added research inputs						
Fencing materials[c]	6.4km	8200	1.3 km	1670	-	-
Microplot cages[c]	160	4100	-	-	-	-
Vehicles (each at $0.10/km)	9100 km	910	1820 km	182	7280 km	728
Incentives in kind	-	1538	-	-	-	-
Total materials costs		17560		2236		2886

---

[a] Includes 0.35 ha of forage crops and 0.25 ha of barley (second year of trial).

[b] Calculated at 3.9 Syrian pounds (SDP) = US$1.

[c] Full costs. Fencing and microplots may be reused for about 5 years.

the harvest labour trials, even though the latter involve more intensive measurements of agronomic variables. This is to be expected when one works directly with livestock. Fencing has a major cost in time, and the regular monitoring of milk production and liveweights also requires considerable labour.

The cost of physical inputs is fairly small compared to the input of technician and scientist time. The grazing trials were most expensive in this respect, largely because of fencing and microplot cages; however, these can be reused over about 5 years. When one considers that there is no physical plant cost for building and maintaining a research station for these trials, materials costs of on-farm work may be lower than those of on-station research.

Methods of Analysis

Rotation/factorial trials will be analyzed for agronomic output using standard analysis of variance programs. As with on-station trials, economic analysis of yield data will initially be based on partial budgets using market prices. This will be useful for comparison of the sets of trials with each other and with station data. However, the prices relevant to farmers may differ from market prices. Furthermore, economic analysis should compare trial practices with other options available to farmers. Production costs of forage crops for hay, seed, and straw must be compared with the alternative of purchasing agroindustrial by-products (cottonseed cake, beet pulp, etc.). Costs and benefits of grazing crops must be compared with current spring-feeding practices. Farmers must be interviewed to discover relevant alternatives to trial practices, evaluate possible conclusions, and consider additional means of analysis.

Harvest labour data will be used to add precision to our production cost estimates for forage legumes. Specifically, it will allow us to compare vetch and lathyrus harvest labour requirements, hopefully with a variety of yields. Thus, a simple two-way analysis of variance would suffice for the first stage. In combination with interview data, the trial will also provide information about the relative valuation of family and hired labour and of the management costs of mobilizing labour. This will allow a more thorough economic analysis of yield data from the farmers' point of view using a variety of nonmarket assumptions.

In the case of the grazing trial, partial budgets will be used to estimate the net value of livestock output supported by the grazing crop against the cost of producing the crop. However, this is insufficient because it does not compare the new practice with other options. Thus, the profitability of experimental flocks and farmer-managed control flocks will be compared. Comparisons will be made in terms of both output per head and also output per unit of total investment. The latter comparison, which allows the number of sheep to be a variable, more closely approximates the situation of the farmer who is short of capital.

The unit of analysis depends upon the unit of measurement. Each animal can be considered an experimental unit for variables such as milk production and liveweight changes, where measurements are made on each animal. However, a variable such as herbage intake, estimated roughly from measure of total and residual herbage, can only be analyzed at the flock level.

RESULTS AND DISCUSSION

On-farm trials are a substantial step beyond on-station research. They allow a more realistic testing of new technologies while stimulating new research. However, it is worth reminding ourselves of the limits of on-farm trials and some dangers in their interpretation.

It is already recognized by most practitioners of on-farm trials that total biological yield is not a sufficient basis of analysis. Economic evaluation of results can be a substantial step forward. However, these can be based on heroic assumptions that may not be the best for predicting farmer decisions. Usually, market prices are used to evaluate inputs and outputs, for want of better information. Maximization of marginal productivity, whether per hectare, head, or unit of money, is usually assumed to approximate farmer desiderata. The importance of risk and uncertainty is well known but difficult to include in trial evaluation without substantial data that are not usually generated by the trials themselves. Limitations on capital, labour, land, or livestock may determine the best analytical procedure, but data on these factors are often unavailable and difficult to collect. Furthermore, subsistence aspects of the farming system or culturally determined requirements may make market price analysis of any type irrelevant.

These factors argue for the complementation of economic yield analysis by more general interviews with trial farmers and others. Specifically, farmers should be presented, in their own terms, with the results of economic analyses of trials using various assumptions, and their responses should be incorporated into the evaluation of results. If farmer opinions agree substantially with the basic analysis, this is encouraging. If they do not, this can lead to a more sophisticated model of adoption decisions for the new technology, such as a decision tree (Gladwin 1979).

Nevertheless, the importance of farmers' points of view with respect to trial results must be kept in perspective. Farmers' attitudes may be limited by their experience and by the importance of maximizing their own or their families' utilities. In the case of alternative rotations, the effects on the overall farming system and on livestock management practices could be far-reaching, having an impact well beyond the individual farm family. It is difficult to say a priori what the effect of new sources of spring or winter feed will be.

Our greatest hope is that we can increase livestock productivity while also having a positive ecological impact. Can we supply a source of feed that reduces degradation of grazing areas and the steppe? Simplistically, an alternative spring feed should do so. However, it is difficult to predict what effect this will have on the overall system. There is the possibility of more livestock being kept or more erratic pressure being placed on grazing lands. Similarly, an increase in winter feed could lead to a more intense use of communal resources in other seasons and possibly their degradation. It is also not clear what effect the increased cropping intensity will have on the soil.

We must remember that on-farm trials are only one tool in the development of new technologies. On-farm trials take research from the station to the farm. They make a tremendous contribution to the evaluation and screening of new technology for feasibility and attractiveness at the farm level. However, they cannot provide the answers to all of these questions. For maximum relevance, trials must be associated with survey research in the design and evaluation stages and macrolevel research (both socioeconomic and technical) on possible impacts of new technologies. Such technologies also have obvious connections with policy issues.

Policy questions are especially relevant to new rotations in the ICARDA region, where there has been much government interest in forage crop production in recent years. Government policy may determine whether a marginally economic technology is attractive or not from the farmer's point of view. For example, in the case of the present trials, government policy with respect to seed production, credit, and input distribution in dry areas could make a tremendous difference. The importance of grazing lands could also be increased, with additional support for cooperative management and conservation of grazing lands in the cultivated zone as well as steppe lands. If on-farm trial results are promising, their extension will usually involve these kinds of factors.

These complexities bear upon all agricultural research, not just on-farm trials. Nevertheless, policy issues and impact evaluation seem to loom larger when one is working on-farm. We like to consider this a sign that we are on the right track. We rely upon our collaborating farmers to keep us there.

Acknowledgments

We would like to thank Drs Cardona, Cocks, Cooper, Keatinge, and Stevens, and Messrs Ferdawi, Haj Dibo, Halime, Oglah, Summakieh, and Touma for assistance in various stages of this research.

REFERENCES

FSP (Farming Systems Program, ICARDA). 1982. Crop productivity and profitability within rotational systems. Research Report 1982, Project III. Aleppo, Syria, ICARDA, 81 p.

FSRP (Farming Systems Research Program, ICARDA). 1980. Farming systems in six Aleppo villages. Aleppo, Syria, ICARDA, Research Report No. 2, Section 3, 188 p.

Gladwin, Christina. 1979. Production functions and decision models: complementary models. American Anthropologist, 6, 653-74.

Harmsen, Karl. 1984. Dryland barley production in northwest Syria: I. soil conditions. In Proceedings of the Soils Directorate/ICARDA Workshop on Fertilizer Use in the Dry Areas. Aleppo, Syria, Syrian Arab Republic Ministry of Agriculture and Agrarian Reform and ICARDA, pp. 12-67.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1984. Annual Report 1983. Aleppo, Syria, ICARDA.

Jaubert, Ronald and Oglah, Mahmoud. 1985. Farming systems management in the Bueda/Breda subarea, 1983/1984 season. ICARDA Research Report. Aleppo, Syria, ICARDA. (In press)

Jaubert, Ronald, Nordblom, Thomas L., and Thomson, Euan F. 1985. On-farm forage trials. In ICARDA, Annual Report 1984. Aleppo, Syria, ICARDA. (In press)

Jaubert, Ronald and Thomson, Euan F. 1985. Sheep feeding strategies at Bueda, N.W. Syria. In ICARDA, Annual Report 1984. Aleppo, Syria, ICARDA. (In press)

Matar, Abdullah. 1984. Barley productivity of rainfed soils as related to soil, precipitation and fertilization in a pilot area of Syria. In Proceedings of the Soils Directorate/ICARDA Workshop on Fertilizer Use in the Dry Areas. Aleppo, Syria, Syrian

Arab Republic Ministry of Agriculture and Agrarian Reform and ICARDA, pp. 121-137.

Nordblom, Thomas L. 1983. Livestock-crop interactions: the decision to harvest or graze mature grain crops. Aleppo, Syria, ICARDA, ICARDA Discussion Paper No. 10, 21 p.

Nygaard, David, Martin, Adrienne, and Bahhady, Faik. 1982. Range and sheep cooperatives and fattening cooperatives in Syria: supplemental feed purchases and credit requirements. Aleppo, Syria, ICARDA, ICARDA Project Report No. 4, 141 p.

Osman, Ahmed. 1985. Palatability of peas and vetches. In ICARDA, Annual Report 1984. Aleppo, Syria, ICARDA.

Osman, Ahmed and Thomson, Euan F. 1985. Productivity, quality and utilization of hay in relation to harvesting stage. In ICARDA, Annual Report 1984. Aleppo, Syria, ICARDA. (In press)

Tahhan, Oreib, and Hariri, Ghazi. 1982. Survey of lentil insects in northern and north-eastern Syria. Lens 9, 34-37.

Thomson, Euan F. 1984. First experience of joint managed forage and grazing trials. In Butler, F.C., ed., Proceedings of Kansas State University's 1983 Farming Systems Research Symposium: Animals in the Farming System. Kansas, USA, Kansas State University, Farming Systems Research Paper No. 6, Kansas State University, pp. 234-250.

Tully, Dennis. 1984. Land use and farmer strategies in AP Bab: the feasibility of forage legumes in place of fallow. Aleppo, Syria, ICARDA, ICARDA Research Report No. 12, 68 p.

USE OF CROSSBRED DAIRY COWS AS DRAFT ANIMALS: EXPERIENCES FROM THE ETHIOPIAN HIGHLANDS

Guido Gryseels and Frank M. Anderson

International Livestock Centre for Africa (ILCA),
P.O. Box 5689, Addis Ababa, Ethiopia

Abstract *Ethiopia has the largest livestock population of sub-Saharan Africa. Because of the importance of cattle as a source of draft power, a high fraction of the bovine biomass kept by smallholders is accounted for by oxen and their support stock. If cows could be used as draft animals in place of oxen, without serious penalty on their performances, then the opportunity would exist for a substantial restructuring of smallholder livestock holdings.*

This paper reports on the International Livestock Centre for Africa's (ILCA's) experiences using crossbred cows as draft animals. It describes the gradual approach that was taken in testing this technology, starting with its use on research farms, complementary on-station research, and evaluation using simulation models and on-farm trials.

During 1984, nine smallholder farmers in the Debre Zeit area used their crossbred cows for land cultivation. They did this at their own risk and expense. The results of the on-farm trials are encouraging and showed that the effects on milk production of using cows for draft were minimal and that there were no major adoption problems.

The on-farm research on using cows as draft animals encountered methodological difficulties arising directly from the nature of livestock enterprises. These included the multiple outputs from the enterprise and the associated valuation problem; statistical estimation problems associated with low-frequency events, which require larger sample sizes than were permitted by the number of cows available for the on-farm trial;

and substantial variability across farmers in management skills and farm resource base leading to differences in operation of the enterprise on each farm.

Further research will involve expansion of the number of farmers testing the technology. This will be supported by detailed station research on aspects of the technology where farmers encountered production problems. The trade-offs among work, milk production, and reproduction at critical stages in the production cycle on different planes of nutrition will be of particular concern.

Résumé *L'Éthiopie possède le plus grand cheptel de l'Afrique subsaharienne. Étant donné l'importance des bovins comme animaux de trait, une grosse part du bétail des petits propriétaires est composée de boeufs. Or, il y aurait une possibilité de restructurer complètement le cheptel du petit propriétaire si, au lieu de boeufs, on utilisait des vaches comme animaux de trait, sans toutefois porter atteinte à la performance de celles-ci.*

La communication qui suit fait état des travaux du CIEA (Centre international de l'élevage pour l'Afrique) sur l'utilisation de vaches de race croisée comme animaux de trait. On y décrit les étapes suivies pour vérifier cette nouvelle technologie : travaux à l'exploitation agricole de recherche puis à la station de recherche, puis application d'un modèle d'évaluation et enfin essais sur le terrain.

En 1984, neuf petits agriculteurs de la région de Debre Zeit ont utilisé leurs vaches de race croisée pour labourer leurs terres, à leurs frais et risques. Les résultats des essais sur le terrain sont stimulants; ils indiquent que l'emploi de vaches comme animaux de trait n'ont que peu d'effets sur leur production de lait, et que les problèmes d'adoption sont mineurs.

Les difficultés recontrées lors des essais pratiques avec les vaches de trait sont d'ordre méthodologique et découlent directement de la nature de l'organisation du cheptel. Il y a, par exemple : le rendement diversifié du cheptel et le problème d'évaluation qui s'ensuit; la difficulté de l'analyse statistique due à la faible quantité d'observations des événements, le nombre de vaches disponibles pour les essais étant peu élevé par rapport à ce qu'exigeait l'analyse; les différences substantielles entre les aptitudes des exploitants à la gestion et entre la base des ressources de leur exploitation, qui se

traduisent par des différences dans le fonctionnement de chaque exploitation.

Les nouvelles recherches envisagées impliqueront un plus grand nombre d'agriculteurs pour tester la technologie en question. Elles seront accompagnées de travaux poussés en station de recherche sur les aspects technologiques qui ont posé des problèmes de production aux exploitants. L'équilibre entre les avantages et les inconvénients de cette technologie sur le plan du travail, de la production laitière et de la reproduction aux étapes critiques de la chaîne de production et en fonction de l'alimentation, fera l'objet d'une attention particulière.

Ethiopia has the largest livestock population in sub-Saharan Africa with some 29 x 10^6 head of cattle, 24 x 10^6 sheep, 18 x 10^6 goats, 7 x 10^6 equines, 1 x 10^6 camels, and 53 x 10^6 poultry. The great majority of the cattle, sheep, equines, and poultry are found in the highland areas of the country. Of the total area of Ethiopia of 1.2 x 10^6 km^2, half are highlands above 1500 m above sea level. Some 80% of the total human population of about 42 x 10^6 live in the highlands.

Agricultural conditions vary widely throughout the country, according to topography, climate, and soils. However, the highlands are generally temperate and comparatively favourable for both crop and livestock production. Smallholder mixed farming is the dominant mode of production in the Ethiopian highlands. The prime contribution of livestock to agricultural production in the Ethiopian highlands is as a source of draft power. Surveys have shown that animal power used for crop-related work (excluding marketing) averaged more than 1000 hours/farm per year. Most of this power was supplied by oxen, but other livestock were sometimes employed for threshing. On a typical farm with 2 ha of cultivated land, oxen are used for draft purposes for 60-70 days/year.

Because of the importance of cattle as a source of draft power in Ethiopia, a high fraction of the bovine biomass kept by smallholders is accounted for by oxen. Smallholder farmers in the country own a total of some 7 x 10^6 working oxen, by far the largest population of such animals in sub-Saharan Africa. Nationally, around

30% of the cattle herd are oxen more than 4 years old. Farmers attempt to produce their own replacement oxen and to this end farmers keep on average from four to five other cattle. Oxen in Ethiopia are traditionally worked in pairs. The International Livestock Centre for Africa's (ILCA's) research (Gryseels et al. 1984) has shown that the availability of draft power is a strong determinant of agricultural productivity on smallholder farms of the Ethiopian highlands. Farmers with more oxen can cultivate more land and can plant more land to cereals than to pulses. As pulses are ordinarily sold at lower prices than cereals, those farmers with less power have, therefore, much lower average incomes than those with at least a pair of oxen at their disposal.

If cows could be used as draft animals in place of oxen without serious penalty on their performance, then the opportunity would exist for a substantial restructuring of farm livestock holdings. Goe (1983) reported on various previous studies related to the working of cows. These studies demonstrated that cows can be used as draft animals for 2-4 hours/day with minimal penalties on production, provided adequate feed is available. Milk loss on days worked appears to range from 10-20%. Much of this evidence, however, comes from temperate breeds of cattle kept in temperate climates, and little is known about the use of cows for draft in subtropical or tropical climates. Cows are routinely used for such purposes in Indonesia and Senegal. In most African countries, farmers will occasionally use cows to overcome a shortage of draft oxen. Cows have been hitched with oxen or horses, donkeys or mules.

Since 1978, ILCA has been conducting research on the use of crossbred dairy cows to improve smallholder dairy production. Initial results (Gryseels and Anderson 1983) indicate average annual milk yields of around 2000 L/cow per year. The net cash incomes of farmers adopting this enterprise increased threefold and the dairy package was shown to be a potent means of making significant welfare gains. However, the introduction of these crossbred cows led to increases in livestock holdings. Farmers were still keeping local cows in addition to the crossbred cow, because they needed them to produce the oxen for land cultivation.

For this reason ILCA decided to initiate research on the use of crossbred cows for both milk production and the provision of draft power for land cultivation.

If successful, this multipurpose use of cows would allow farmers to make more efficient use of available feed resources and to sell much of the present unproductive stock. With the rapid growth in rural populations now occurring in the country, farm sizes are steadily diminishing and progressively larger proportions of existing grazing land are being taken into cultivation for crop production. Livestock feed resources are diminishing and there is a need to find ways and means of reducing the number of animals kept to support agricultural production.

This paper reports on ILCA's work using crossbred cows as draft animals. The research was conducted within the framework of ILCA's Highlands Programme, which has the basic objectives of identification and testing of ways of improving the overall productivity of mixed smallholder farms by increasing the technical and economic efficiency of livestock enterprises. Particular emphasis is given to enhancing the complementarity of the livestock and crop components. Results and experiences of the research in Ethiopia will, in many cases, have direct relevance to other highland smallholder situations in sub-Saharan Africa.

The program has adopted the farming-systems approach to research. This integrated and problem-oriented approach stresses on-farm technology testing and appraisal, complemented by relevant station research on individual components in cases where greater experimental control is advantageous (Gryseels et al. 1984). The evaluation of technology on a whole farm basis, through farmer-managed tests, is a crucial and essential part of the approach.

On-farm trials have been initiated on a range of topics. These include the use of crossbred cows and forages for smallholder dairy production, the use of single oxen rather than the conventional pair for land cultivation, the construction of ponds and dams using oxen-drawn metal scoops, the use of biogas digesters, and the use of crossbred cows as draft animals in addition to their primary role as milk producers.

A favourable outcome of the research on draft cows would allow farmers to reduce the numbers of stock required to satisfy their draft power needs, thereby allowing a substantial efficiency gain in farm production. As already noted, the main use of draft animals in tropical Africa, including Ethiopia, is for cultivation. However, cultivation in most of these systems must be done during a limited period each year. Because cows cannot be used for work at all times in their reproductive cycle without penalty on either milk production or calving frequency, any substitution of oxen by draft cows will only be accepted by the farming community if it does not prejudice their ability to cultivate in a timely way.

The next section of this paper describes the initial research approach, including the "cows-for-work" enterprise on research farms operated by ILCA, complementary on-station research, and the application of a linear programming model to assist economic evaluation of the technology. The main results of the application of a simulation model to assist prescreening of the technology for a range of production assumptions are also presented. The following section describes the materials and methods for on-farm testing. The last section summarizes the results of the on-farm trials with the technology and the outlook for further research on the topic.

INITIAL RESEARCH APPROACH TO DRAFT COW TECHNOLOGY

Research Farms

The crossbred cows-for-work technology was tested first in 1980 at the ILCA Debre Zeit Station on two research farms. These research farms (often also named "unit" farms or "model" farms) were managed and operated by ILCA employees[1] on a fixed salary plus an annual bonus as part of an incentive scheme. In addition to providing a direct means of assessing the technical and biological feasibility of a range of alternative enterprise combinations, the research farms served as a clearinghouse for more innovative enterprises that might later be introduced to the farming community (Gryseels and Anderson 1983). One research farm had 2.5 ha of arable land on light soil and 1.5 ha of grazing land. The other one had 4 ha of arable land and 1.5 ha of nonarable bottomland used for grazing and haymaking. Each one of the farms had three crossbred dairy cows (Friesian x Boran), which were used for all land cultivation. No particular technical problems were encountered in using the cows for draft purposes.

---

[1] These employees were farmers, with no formal educational background, recruited from the local farming community.

Complementary On-Station Research[2]

Once ILCA had demonstrated that the technology was feasible on research farms, it was decided to conduct formal experiments with crossbred cows to determine the technical trade-offs between milk production, calving interval, and work output when cows are also used as draft animals. Thirty-two crossbred cows (Boran x Friesian) were purchased in 1981 and were used in an experiment to determine the effects of work on the reproductive and productive performance of cows. Sixteen cows served as a control group and were milked only, whereas the other 16 were milked and at the same time provided draft power for cultivation.

After the end of the second lactation there were no significant productivity differences between draft and nondraft animals as regards milk production (1700 vs 1825 kg), lactation length (288 vs 274 days), calf birth weight (30 vs 30.5 kg), calving interval (353 vs 352 days), and number of services per conception (1.21 vs 1.64). The number of hours worked by each pair of crossbred cows in the trial was sufficient to provide for the cultivation needs of the average smallholder farm of 2.5 ha.

---

[2] This section draws heavily on Agyemang et al. (1985).

It was concluded that with proper feeding crossbred dairy cows could be used to provide draft power without significant adverse effects on reproduction and milk production. However, these results were obtained under research station conditions where the feeding and health care regimes were substantially better than those achievable under farm conditions. It was, therefore, necessary to test further the technology under on-farm conditions.

Ex Ante Technology Evaluation Using a Linear Programming (LP) Model

A single-period LP model was constructed to represent production on a typical Ethiopian smallholding. The basic model has 41 activities and 36 constraints. A series of solutions was generated to investigate the effects of the introduction of various technologies into the traditional farming system. The introduction of a crossbred dairy cow, as well as forage crops as enterprises, into the farm plan increased the farm gross margin in the optimal solution from ETB 476 to ETB 867,[3] an increase of 84% over the gross margin in the basic solution where only traditional enterprises were included in the matrix. A pair of oxen was still required for cultivation in this plan. Allowing the farmer to keep two crossbred cows that could also be used for work further increased the gross margin of the optimal farm plan to ETB 3,212. It was assumed in that farm plan that the penalty of work on milk production would be a 15% yield reduction. Oxen-keeping and sheep enterprises were not included in solution and their feed resources were diverted to the crossbred cow enterprise.

The model showed that using crossbred cows for draft purposes as well as for milk production was likely to be a profitable development option. However, the technology has still to be tested under farmer conditions where nutritional stress is a more critical factor in production than under research station management. On-farm trials with the technology were initiated in 1983.

---

[3] One Ethiopian Birr (ETB) = 0.50 US$.

Ex Ante Technology Evaluation Using a Simulation Model

The LP approach provides useful indications of the implications for optimal enterprise mix, farm profitability, and resource valuation when the cows-for-work enterprise is included as a production option on a traditional representative farm. Sensitivity analyses using the LP model also allow threshold productivity levels for the new enterprise to be estimated, above which the enterprise can be expected to be an attractive economic option for the smallholder producers whose situation is being modeled.

However, the LP formulation cannot be used to assess the impact of different work rules limiting work by cows at different stages in their production cycle, when these rules are matched with the consideration that in most African farming systems fieldwork must be completed within a well defined period each year. If cows are worked immediately before and after calving then both reproduction and milk production can be impaired. The biological relationships involved are not well established, but the general problem was of sufficient concern to require that it be addressed as part of the overall assessment of the technology. For example, if a pair of cows is used for cultivation and the farmer has only two or three cows, then there will be some probability that on any one day in the cultivation season he will have the necessary pair available to work. If a pair of cows is not available on enough days to complete the required work before the end of the cultivation season the cows-for-work technology will not substitute for working oxen. Such an outcome would cause justifiable reluctance on behalf of farmers to adopt the technology.

A stochastic simulation model was developed to allow the probability of cows being able to cultivate specified areas, given a range of assumptions about the mean duration and variability in length of the cultivation season when various limitations were imposed on the availability of cows for work at specified periods in their production cycle. The model is described in Anderson (1985a). It was applied to the smallholder production situation in Debre Zeit. The results of the application are given in Anderson (1985b).

The model was run using operating rules and production assumptions corresponding to expected farmer practice. It predicted that farmers on an average farm in the area would be able to satisfy between 75 and 90% of their work requirements using cows only from a three-cow herd. Relaxation of the assumptions used in the model to conform to the results expected from technical innovations being investigated in complementary research increased the probability that cows only will be able to complete the required work to over 0.95. These results suggested that smallholder farmers in the Debre Zeit area could be expected to encounter minimal difficulty over time in completing their cultivation work in a timely way using cows only.

Both the LP and simulation models proved to be useful adjuncts to the on-farm tests of the technology described in the following sections. By prescreening the technology in these ways the researchers gained confidence that the cows-for-work enterprise could be expected to be biologically feasible and economically profitable when managed under smallholder conditions. Also, the range of production assumptions assessed using the models could not be replicated either on-farm or on the research station, so this exploratory research with the models did away with the need for much of the physical experimentation that might otherwise have been considered necessary.

MATERIALS AND METHODS FOR ON-FARM TESTING

Research Locations and Traditional Farming Systems[4]

ILCA's field research in the Ethiopian highlands has concentrated on the central highlands where smallholder mixed farming is the dominant mode of production. Rainfall here averages between 600 and 1200 mm/year, of which about 70% falls in the main rainy season between July and September. Farm sizes range from

---

[4] This section draws on Gryseels et al. (1984).

0.5 to 5 ha,[5] and around 80% of all farm produce is used for subsistence consumption. About two-thirds of the cultivated land is sown to cereals. Most of the remainder is sown to pulses. The proportion of fallow land in different parts of the highlands is quite variable. In some areas, almost no land is fallowed, but elsewhere fallow periods of up to 12 years following 3 crop years are common.

The major crops grown are teff, wheat, barley, maize, sorghum, horse beans, chickpeas, and field peas. Grain yields average between 500 and 1000 kg/ha sown. Access to modern inputs is limited. For example, fewer than 10% of farmers regularly use either chemical fertilizer or improved seed. Most farmers own livestock and a typical farm inventory includes two oxen and young stock, a cow, a few sheep, and a donkey. As most livestock manure is used as household fuel, only small amounts are returned to the fields as fertilizer.

Cattle are kept mainly as a source of draft power and for manure. Milk, meat, and hides are less important products. Livestock are privately owned and, as such, are an important form of investment and financial security. Usually, only oxen are used for cultivation. Productivity of all livestock is low, reflecting an underexploited genetic resource and generally inadequate nutrition, particularly during the extended dry season of up to 7 months each year. For example, milk offtake from indigenous Zebu cows kept under traditional management rarely exceeds 400 kg for lactations of 7 months and calving intervals average 2 years. Sheep are also comparatively unproductive as, along with cattle, they are subject to heavy endoparasite burdens and to extended periods of nutritional stress.

---

[5] In Ethiopia, land is not individually owned but is allocated by the Peasants' Association (PA) of which each farmer is necessarily a member. The size of individual allocations, comprising several plots, depends on family size, local population density, and the policies of the local PA. Land distribution takes account of the different fertility levels of the soils within the land area of the PA. Each PA has on average 250 members and controls around 800 ha of land.

In addition to research undertaken at ILCA's headquarters in Addis Ababa, field work is carried out in two study areas where ILCA research stations have been established: around Debre Zeit, 50 km south of Addis Ababa at an altitude of 1850 m, and around Debre Berhan, 120 km northeast of Addis Ababa at an altitude of 2800 m. The area around Debre Zeit is intensively cultivated with virtually no arable land kept fallow. Here teff (Eragrostis tef) is the principal cereal. Debre Berhan is representative of the higher altitude zone of the country. Frosts, hail, and a shorter growing season, in addition to low soil fertility, cause the area to be less productive than Debre Zeit. Most cultivated land around Debre Berhan is sown with barley.

Throughout most of the Ethiopian highlands the land is tilled using a pair of oxen of one of the indigenous Zebu breeds[6] that pulls the locally made traditional cultivation tool, the maresha.[7] The power output of oxen pulling this plow is dependent on their body weight, nutrition and health status, the terrain and soil condition, depth of plowing, working speed, pass number,[8] and the training of the animal and the skill of the handler. Depending on the soil type and the crop, the land is cultivated up to six times before planting.

Oxen are commonly worked for 4-9 hours/day, depending mainly on the time available for soil preparation.[9] Traditionally, animals within the Debre Zeit area are worked throughout the day with few breaks. In contrast, farmers in the Debre Berhan areas normally give their oxen a rest period at mid-day during which animals are watered and fed.

---

[6] An ox in working condition weighs about 250-300 kg.

[7] The maresha is constructed by the farmer from wood and has a metal tip for penetration. This plow does not turn a furrow like the conventional mouldboard plow and cultivates to a depth of about 15 cm.

[8] Consecutive plowings with the maresha are done in different directions across the plots. Pass numbers refer to the number of cultivations done in the season.

[9] Shorter working days are often associated with longer distances to watering places and with watering frequency, which varies with the season.

General Approach

Farming-systems research in ILCA's Highland Programme is operating at three levels: ongoing studies with farmers in the traditional system ("control" farmers), studies with a second group of farmers who have adopted all or part of an improvement package or a new technology designed by ILCA ("test" farmers who ideally have been control farmers before), and studies on research farms where other, more innovative and risky enterprise combinations are tested under ILCA management. Control and test farmers are from the PAs surrounding the ILCA stations. In the development of new technology, ILCA regularly consults with local farmers and technical officers of the Ministry of Agriculture to discuss the ongoing research to ensure its relevance to the needs of the farming population. Whenever ILCA has a technology available that has been successfully tested on-station, field days are organized to discuss this technology with the local farmer population and extension agents.

ILCA then seeks volunteer farmers willing to test the technology at their own expense and risk. Normally, only technical advice is provided, and occasionally short-term credits to assist in the financing of more expensive technology when no other means of credit are available. Insurance has been included in the package when large expenses are involved as, for example, in the case of the purchase of crossbred cows, which cost over US$300 per head.[10] For inputs to other technologies, no guarantees were offered.

---

[10] This insurance system guaranteed replacement of any cow producing less than 700 kg of milk in the first lactation or had fertility problems, if these were considered not to be due to management failure. A committee consisting of farmers and ILCA staff decided upon compensation.

Farmer Selection and Trial Design

Since 1978, ILCA has been monitoring the whole farm performance of a group of 40 smallholder farmers at Debre Zeit who each purchased a crossbred cow. Results of this work are summarized in Gryseels and Anderson (1983). Traditionally, cows are not used for cultivation in the Ethiopian highlands. Most farmers and extension agents were skeptical about the idea of using cows for draft purposes.

In 1983, on-farm trials were initiated at Debre Zeit with five smallholder farmers who used their crossbred cows as draft animals. During 1984, an additional four farmers joined the research when they adopted the same production strategy.

Before they joined the cows-for-work program, each test farmer had one crossbred cow and most had a crossbred heifer or young bull. All farmers were sold an additional crossbred cow so that they would have a pair available for land cultivation.

The farmers volunteered for participation in the trial after a demonstration of the technology at the ILCA station and subsequent individual discussions with ILCA staff. They were mostly young farmers, but they were cultivating more land than the average holding in the area. There was no formal trial design. The farmers live within a radius of 20 km around the station. The objective of the on-farm trials was to assess the suitability of the technology to farmer conditions. Every farmer tested the technology at his own risk and expense and was free to adapt it to his own circumstances as he considered appropriate. Thus, considering the small number of farmers involved, it was not possible to implement a formal experimental design. Furthermore, some farmers cultivated all their land with the cows, others only a part.

Monitoring the Impact

The test farmers were visited weekly by the ILCA enumerator and twice monthly by graduate research staff. Production data collected included:

(a) Personal and demographic data of the farm family (annually);

(b) Measurement of land and livestock holding (annually);

(c) Weights of crossbred cows (monthly);

(d) Cropping pattern and input use (annually);

(e) Cultivation details and field activities per plot: hours worked and area cultivated per day, cultivation depth, use of human labour (weekly);

(f) Crossbred-cow feeding record (weekly);

(g) Milk-production record (a farmer self-recording system was used and checked every 2 weeks);

(h) Breeding and health records (weekly);

(i) Crop-calendar data on seeding, weeding, and harvesting dates (weekly);

(j) Inputs to the crossbred-cow enterprise including feed concentrate usage, veterinary care products, and grazing requirements (weekly); and

(k) Outputs of grain, straw, and crop residues (annually).

Graduate research staff involved in the work included an agricultural economist and an agricultural engineer. Additional visits were made by other staff when special problems arose.

The farmers owned the animals and received no compensation for cooperation in the research. During an initial 3-month period they could purchase feed concentrate from ILCA. This was sold on a cash basis, and was intended to assist the farmers to overcome a temporary feed shortage while they were growing forages. ILCA also helped them to acquire hand sprayers to be used against ticks. These sprayers were paid for by the farmers who shared one between every two farmers.

RESULTS AND DISCUSSION OF THE ON-FARM TRIALS

Land and Livestock Holdings

During 1984, nine farmers used their crossbred cows for their land cultivation. These farmers were on average 40 years old and had an average family size of nine. The size of their holding averaged 3.5 ha with a range from 1.9 to 5.3 ha (CV 28%). On average, 82% of the land was sown in cereals (mainly teff), 12% to forage crops (oats and vetch), and 6% to pulses (horse beans and chickpeas). Regionally, more than 30% of the cultivated land is sown with pulses. Cereals require around 60% more draft power and labour inputs per hectare than pulses. However, farm gate prices for cereals are more than twice those for pulses. Using cows for traction greatly increased the availability of draft power; hence, the greater fraction of cereals, and no land was left fallow. Pastures are communally owned.

The test farmers had relatively large livestock holdings. They owned between two and three crossbred cows and three crossbred young stock, two local cows, one or two local oxen, and four other local cattle of mixed ages, a few sheep or goats, two donkeys, and four chickens. These holdings are substantially larger than the regional average. On average, the value of the livestock holdings of test farmers was ETB 4400 or more than three times that of a traditional holding.

Cow Output

Six of the farmers did almost all of their cultivation (more than 80% of the land) with the crossbred cows. The remaining three received their additional cows late during the cultivation season and, as a result, they used them to cultivate only 40% of the total of the land. On average, around 450 animal hours were necessary for land preparation and planting. Cows were worked 4 hours/day for the seedbed preparation, but 6 hours/day during the seeding period. Whenever a cow was sick or due to calve, a farmer paired up his remaining cow with an ox or a heifer.

The crossbred cows were about 40% faster than the traditional oxen in cultivating the land. Farmers also achieved a greater plowing depth (17 cm against 15 cm) and did a larger number of cultivations than other farmers were able to do with the traditional method of cultivation (five or six against four). Teff yields of cow-traction farmers averaged 1320 kg/ha, against only 1000 kg/ha for other farmers in the area. This is, however, also attributable to the greater use of chemical fertilizer. Farmers with crossbred cows have significantly higher cash incomes than traditional farmers and a substantial fraction of this income is used to purchase additional farm inputs such as fertilizers.

The cows needed some training before they could be used as draft animals. This took only 10-15 days. One method was to pair them up with an ox first. Another one was to have them tied and led by a second handler. One cow was too wild and could not be trained. The number of working days averaged 40 (plowing only). Adjusted average annual milk yield of working cows over a 305-day period was 1300 kg (CV 32%). On working days, the penalty on milk yield was around 1 L of milk, or around 15-20% of the daily production. In the cultivation season of 1984, farmers stopped their cows working only a few days before calving and worked them again in some cases the day after. Overall, farmers were very pleased with the performance of the cows. They like the idea of one animal simultaneously providing milk, meat, manure, and draft power.

Discussion

The on-farm trial has shown that the use of crossbred cows for both traction and milk production is feasible, and that it has minimal effects on milk production. Farm income can increase dramatically through an increase in area cultivated, a higher fraction of land being sown to cereals and the opportunity of greater livestock sales. Farmers could also finish their cultivation earlier and used the newly available time for other enterprises. Some additional labour was used for weeding. The sample size of the on-farm trials were, however, too limited to capture the effects on cow fertility. These are long-term effects and one would need large samples (more than 100 test farms) and extended time periods (minimum of 3 years' observation) to obtain statistically significant information on this effect.

On-farm trials gave the research clear indications on how farmers relax certain conditions considered by researchers to be ideal. Researchers assumed the farmer would stop working the cows 30 days before calving and for some 40 days after calving. In reality, farmers accepted much smaller time periods. It is also not yet known what the performance of such cows is under greater nutritional stress.

The practical problems reported by farmers arising with the use of crossbred cows for draught were mainly related to their training. Although in most cases it only took 10-15 days, two farmers complained that it had taken them 2-3 months before the cow was fully accustomed to work. Farmers were also looking for practical ways to plan seasonal breeding to avoid calving to coincide with the cultivation season.

The other problems were not related to using the cows for draught but to the management of crossbred cows in general. These include issues related to breeding, marketing, fodder production, calf rearing, and animal health. In so far as the routine use of cows as draft animals is an extension of the crossbred-cow enterprise, it is relevant to highlight some of the production issues related to the basic innovation.

The cows used in the research are halfbred Friesian x Boran. Experience has shown that cows with a higher level of introduced blood require more sophisticated management that is within reach of only a small fraction of the highland farmer population. The question arises of how to keep the breed fraction approximately constant. Most farmers prefer to use a purebred Friesian bull, but this quickly leads to a situation where a high fraction of the cow population has more than 75% Friesian blood, a level at which production problems are common.

Milk marketing is a severe problem during certain periods of the year. The majority of people in the Ethiopian highlands belong to the Ethiopian Orthodox faith that prohibits the consumption of foodstuffs containing animal protein, except fish, for around 150 days per year. This indicates the need to evaluate the option of processing milk into a range of storable, transportable and higher value products. ILCA has initiated a research program to improve small-scale dairy technologies. At existing price ratios, rearing male calves for beef is unprofitable and there is a limited market for veal.

The use of crossbred cows for draft purposes requires high-quality feedstuffs to compensate for energy expenditure during work. Farmers were feeding wheat bran and middlings on days worked. However, the supply of these feed concentrates is irregular. ILCA is now evaluating the use of molasses/urea blocks to increase the digestibility of low-quality feedstuffs and crop residues, which comprise a major portion of cattle diets.

CRITICAL REVIEW AND OUTLOOK

The crossbred cows-for-work technology has been screened and evaluated using various approaches. Although all have their merits, there have also been serious limitations. The testing on research farms is no substitute for on-farm testing as it is risk-neutral, and the cows are under minimal nutritional or health stress. The formal experiment on-station was designed to show that crossbred cows could cultivate the land of an average smallholder who has 2.5 ha. This hypothesis was easily proven. However, the cows were not worked hard enough. As a result, the use of the cows-for-work did not have any observable impact on milk production or fertility. To determine the technical trade-offs that exist, a much more rigorous and intensive work regime will be necessary.

The on-farm trials gave strong indications that the technology is feasible also under farmers' conditions. However, the interpretation of results is difficult for reasons related to the characteristics of livestock research. These can be listed as follows:

(a) Problems in evaluating a technology for multipurpose animals given their multiple outputs (draft, milk, manure, calves, meat, etc.). Moreover, some of these products have a monetary value, others do not. It is difficult to attribute causal linkages for differential rates of adoption of the technology by farmers in such situations.

(b) The absence of a control group, the practical impossibility of having within-farm replicates, and the fact that farmers have only a few large ruminants make it difficult to produce statistically acceptable statements. In addition, effects on reproductive performance are long term and can only be assessed using large sample sizes. This low-frequency event problem has also substantial implications for the statistical interpretation of the results.

(c) Management factors are critically important. If farmers do not water and feed their stock regularly, the outcome of the experiment will be prejudiced.

(d) Testing can only be in operational-scale enterprises.

(e) Sociological considerations arising from the close relationship farmers have with their cows.

(f) The high risks involved for the farmers in participating in the research because of the scale of investment involved.

During 1985, the research program will be expanded at three levels. First, the on-farm trials will continue, but the sample size will be increased to about 50 farmers. These additional farmers have offered during the last few months to participate in the research and to use their crossbred cows for draft.

Second, increasingly, emphasis will be given to the use of cows worked as singles rather than in a pair. The importance of this option was also highlighted in the results of the simulation model described in this paper. A development toward the use of single cows would further reduce the number of animals required at the farm. Third, a new formal on-station experiment is being planned to investigate further the technical trade-off between work, milk production, and fertility. The experiment will be conducted with more than 40 cows on three levels of nutrition and performing three different levels of work.

To date, ILCA has only evaluated the use of cows for land cultivation. Their use as draft animals for transport has not yet been evaluated. In the future, ILCA will also be concerned with this aspect.

The use of crossbred cows for draft power is an exciting development option. Although there is a need to undertake larger scale on-farm and on-station research to provide additional technical information, the results to date have been extremely encouraging. If adoption of the technology occurs on a large scale, it will have far reaching implications not only for the peasant farmers of Ethiopia but also for the many millions of smallholders in sub-Saharan Africa.

REFERENCES

Agyemang, K., Astatke, Abiye, Anderson, F.M., and Woldemariam, Woldeab. 1985. Early indications of effects of work on reproductive and productive performance of crossbred dairy cows in the Ethiopian highlands. Working document, Highlands Programme, ILCA, Addis Ababa. Addis Ababa, Ethiopia, ILCA.

Anderson, F.M. 1985a. A model to evaluate the effectiveness of milking cows used as draught animals in different production settings. Working document, Highlands Programme, ILCA, Addis Ababa. Addis Ababa, Ethiopia, ILCA.

1985b. Application of a simulation model to pre-screen the applicability of using milking cows as draught animals in the Debre Zeit area of Ethiopia. Working document, Highlands Programme, ILCA, Addis Ababa. Addis Ababa, Ethiopia, ILCA.

Goe, M.R. 1983. Current status of research on animal traction. FAO, Rome, Italy, FAO. World Animal Review No. 45, 2-17.

Gryseels, G. and Anderson, F.M. 1983. Research on farm and livestock productivity in the central Ethiopian highlands: initial results, 1977-1980. ILCA Research Report No. 4. Addis Ababa, Ethiopia, ILCA.

Gryseels, G., Astatke, Abiye, Anderson, F.M., and Assamenew, Getachew. 1984. The use of single oxen for crop cultivation in Ethiopia. ILCA Bulletin No. 18. Addis Ababa, Ethiopia, ILCA.

BEEF PRODUCTION FROM SUDANESE CATTLE FED DIETS BASED ON AGROINDUSTRIAL BY-PRODUCTS: TRIALS IN PRIVATE FEEDLOTS

A.Y.M. Nour and F.A. Hamza

Department of Animal Science, Faculty of Agricultural
Sciences, University of Gezira, P.O. Box 20,
Wad Medani, Sudan

Abstract *Traditionally, cattle feedlot operators (CFO) in the central region of Sudan finish their cattle for slaughter on diets made from sorghum grains and cakes. They prefer their diets to those prepared by the Kabaroo tenants union feed mill, which contains 50% wheat bran. Although inexpensive, it was rejected by CFO and this caused serious marketing problems for Kabaroo. For the producers, grain and cake prices skyrocketed. Their margin of profit narrowed and some operated at a loss. The objective of this work was to produce an inexpensive alternative of nutritionally balanced diets processed by Kabaroo that would capture the interest of CFO and fetch a better market than the old Kabaroo diet.*

An informal survey was carried out and 10 out of 80 CFO were interviewed. The Kabaroo mill was visited and trials on their diet were made with no success. New diets were suggested, including a warming-up diet high in protein and a finishing diet high in energy and processed by Kabaroo. Arrangements were made and Kabaroo sold two of the CFO feeds at cost price. One of the CFO continued the experiments and trials were made on his feedlot. Cattle were randomly divided into two groups, one group was fed the CFO diet and the other received the new diets. Intake was monitored and days on feed were recorded and the degree of finishing was assessed subjectively. It took the group on the new diets 25 days longer, but the cost of feeding was less than the CFO diet.

The CFO ordered another 100 t from the warming-up diet. It was planned to replicate the experiment, however, because of the drought, a new feeding strategy was proposed. Three more CFO joined in and cattle were fed crop residues until the market conditions improved. Feeding grains to cattle is now prohibited because grains are needed by the human population. New diets based on alternative sources of energy were proposed. On-feedlot trials were planned and arrangements were made with Kabaroo. Diets will be critically evaluated using objective measurements of animal performance.

Résumé Selon la tradition, les exploitants de parcs d'engraissement (EPE), dans le centre du Soudan, assurent la finition des animaux de boucherie avec des rations composées de grains et de tourteaux de sorgho. Or ils préfèrent utiliser leurs propres rations plutôt que celles préparées par la minoterie de l'association des fermiers de Kabaroo, qui contient 50 % de son de blé. Bien que peu coûteuses, les rations de Kabaroo ont été refusées par les EPE, un refus qui a causé de sérieux problèmes de marketing à l'association. Le prix des grains et des tourteaux payé par les producteurs a monté en flèche. Leur marge de profit a diminué et certains ont travaillé à perte. L'objectif de la présente recherche a été de produire des rations substitutives, peu coûteuses, et nutritionnellement équilibrées, qui seraient préparées par Kabaroo et seraient susceptibles d'intéresser les EPE et d'avoir un meilleur marché que l'ancienne ration Kabaroo.

On a donc effectué un sondage informel et interviewé 10 des 80 EPE. On a visité la minoterie Kabaroo et fait l'essai de sa ration, mais sans succès. On a donc proposé de nouvelles rations, y compris une ration de réchauffement à teneur élevée en protéine et une ration de finition hautement énergétique, qui ont été préparées par Kabaroo. Suite à des arrangements avec l'association, celle-ci a vendu deux rations des EPE à prix coûtant. L'un des EPE a accepté de poursuivre l'expérience et des essais ont eu lieu dans son parc. Après avoir divisé aléatoirement le bétail en deux groupes, on a utilisé la ration des EPE pour l'un et les nouvelles rations pour l'autre. On a observé la consommation, enregistré le nombre de jours pendant lesquels les rations ont été administrées et évalué le degré de finition pour chaque sujet. Le groupe ayant

reçu les nouvelles rations a mis 25 jours de plus pour atteindre le point de finition, mais le coût de la finition a été inférieur à ce qu'il aurait été si la ration des EPE avait été employée.

Les EPE ont commandé un autre 100 t de la ration de réchauffement. On avait prévu de refaire l'expérience. Cependant, à cause de la sécheresse, on a proposé une nouvelle stratégie alimentaire. Trois autres EPE ont rejoint l'équipe des essais, et le bétail a été nourri avec des résidus de récoltes jusqu'à ce que le marché s'améliore. La distribution de céréales au bétail est maintenant défendue, celles-ci étant réquisitionnées pour l'alimentation humaine. De nouvelles rations composées de substituts énergétiques ont été suggérées, des essais dans les parcs prévus, et des arrangements avec Kabaroo conclus. Les rations doivent être scientifiquement évaluées à l'aide de mesures objectives de la performance des animaux.

Of the total domestic farm animals in Sudan (cattle, sheep, goats, and camels), cattle make up more than 35% (18×10^6) of the total. Cattle are raised by pastoralists who migrate with their herds in search of feed and water. More than 48% of the total cattle population is found in the Darfur and Kordofan regions of western Sudan. Cattle in these regions are predominantly of the western Baggara types. They make up 80% of the northern cattle population and provide the country with most of its beef requirements. Furthermore, they are the principal type of cattle exported. These cattle are shorthorn Zebu with body colours that range from white to dark red and dark brown. These cattle are mostly driven on the hoof when grasses are available on their routes. Recently, special livestock trains were also used for transportation of cattle to the major marketplaces in Omdurman and Wad Medani around which traditional and semimodern private feedlots are situated.

Cattle rearing, especially for those that are considered to be the major beef types (western Bagara), is mostly dependent on natural grazing. In local feedlots, crop residues and concentrate feeds are fed to cattle to finish them for slaughter or export. Other types of cattle such as the Kenana and Butana are kept mostly for their milk and are fed mainly on irrigated forages supplemented with concentrates. Others, such as Umbaroro, Nilotic, and Dwarf cattle contribute to the local-market beef supply with very few used for export. Cattle on the range experience seasonal shortages of feeds that adversely affect liveweight gains, especially during summer. Such cattle require more intensive feeding in the feedlot. Cattle transported to the marketplaces are mainly finished for slaughter on grains, wheat bran, and oil cakes for 60-90 days. Animals destined for export will enter a fattening period the length of which depends on their condition and the requirements of the external market. Those sold for the local market are either slaughtered after grass feeding if they are in a good condition or fattened for a variable period that may extend to 120 days depending on their condition and expected selling price.

According to the Livestock Meat and Marketing Council (LMMC) (LMMC, personal communication), the producer price represents only 48% of the consumer price per head, whereas various duties and taxes represent 11% of the consumer price and the remaining 41% is accounted for by profit margins and the commission of various middlemen (AOAD 1982). However, feed costs account for 50% of the total inputs. The profit margin can be very narrow if prices of feeds increase. This has been especially true during the past 2 years when the shortage of grain forced the producers to rely heavily on oil cakes and brans. In addition, the competition for the exportation of oil cakes made their prices as cattle feeds skyrocket. The shortages of grains last year limited their use for cattle feeding except for those destined for export.

During 1985, grain production was low to the extent that it was unavailable even for the poultry industry. The prices increased five times over the previous year (1984). Also, sorghum grain (dura) feeding is not feasible in a country where dura constitutes the stable diet of the human population. The situation was aggravated by the drought and resulted in a decline in grain production by 1.5 t from the 1984 total grain production. Because energy is needed to raise and fatten cattle, alternative sources must be sought if cattle producers are to remain in business.

Cattle prices in the central markets (Omdurman and Wad Medani), before and after finishing, are affected mainly by the seasonal fluctuations in the supply of cattle. Cattle prices also increase due to the present high inflation experienced by the Sudanese economy (AOAD 1982).

The major beef-production systems are those of the Nomads complemented by fattening operations around Omdurman and Wad Medani. The current practice is to leave cattle on bare land on the outskirts of these towns and feed them on grains and agroindustrial by-products.

The condition of cattle coming from the range varies considerably depending on rainfall, the nutritive value of pasture grasses and legumes, the length of the journey to the marketplaces, and internal parasites and diseases. Cattle heading toward marketplaces are usually vaccinated against infectious diseases such as anthrax, rinderpest, haemorrhagie septicaemia (HS), and black quarter (BQ). However, in the feedlots they are not drenched with antihelminthic or sprayed against ticks. When fed during the rehabilitation period, animals experience compensatory gains before entering the fattening stages. A well-balanced diet is necessary to make decent gains, and profit depends on the efficiency of the whole operation and particularly on the initial cost of the cattle, availability and cost of feed, quality of feed gains, losses during transportation and feeding, related duties and other costs, and selling price.

Marketing channels are still dominated by wealthy merchants through a network of financial and personal contacts. Currently, LMMC provides market information and transport and is currently trying to adopt an auction system for marketing. Because of the general inaccessibility, however, to credit and capital, trading remains in the hands of the large merchants. Nevertheless, small producers have started to participate in the marketing process. The total capital of these producers is limited and they must rely on personal contacts to provide credit. They cannot afford to lose money, but this is inevitable when the price of feed rises sharply and there are no alternative feeding strategies to fall back on. A thorough knowledge of nutrition is, therefore, most helpful.

PROBLEM IDENTIFICATION

Recently, a general feed-processing industry was established. The first feed mill was established in 1970, and the number of feed mills increased gradually until the mid-70s when the number reached 27. The main purpose of the feed mills is to formulate least-cost rations for different production functions including poultry production and dairy and beef cattle fattening.

Poultry feeds, because of the several ingredients needed to meet their exacting requirements, gained popularity. However, the demand for processed feeds for finishing cattle is very low. This is because animals are either slaughtered off the range or are traditionally finished on ingredients such as dura, cakes, and brans. Traditional livestock producers believe that their cattle can perform better on their own blends than when fed feeds from the feed mills. In most cases, the feed they blend for their cattle is poorly balanced, some are low in protein and high in energy or high in protein and low in energy and are fed irrespective of the animal's needs. Some are even fed straight cottonseed cakes. Sorghum straw is usually fed as a filler.

The feed processed by the mills is generally formulated without the benefit or advice of an animal nutritionist. But even though some mill operators claim to follow scientific standards, the drawback is that they are formulated using exotic standards because the requirements of Sudanese cattle are not known.

Furthermore, because there is no quality control for feeds in the country, emphasis is on profit, which most of the time is at the expense of quality. At the feed mills, they are generally not inclined to conduct field trials on their diets. This is especially true for the Kabaroo feed mill near Hesahiesa in the central region. The mill was established as a sister plant to the Gezira and Managil tenants union's flour mill to make use of flour milling by-products, mainly wheat grain rejects and bran.

The Kabaroo feed mill produces a broad spectrum diet (Table 1) claimed to be useful for different production functions such as growth, fattening, and

Table 1. Ingredient composition of different diets (%).

Diet/ingredient	K	SWU	AWU	Finishing	P
Sorghum grains	-	-	-	-	20
Wheat grain rejects	25	25	25	32	-
Cottonseed cake (undecorticated)	15	33	33	28	60
Wheat bran	50	22	32	28	20
Molasses	9	7	7	9	-
Sorghum straw	-[a]	10	-[a]	-[a]	-[a]
$CaCO_3$	-	2	2	2	-
Salt (NaCl)	1	1	1	1	-

Note: K = Kabaroo diet, SWU = suggested warming-up diet, AWU = actual warming-up diet, and P = producers' diet.

[a] With other diets sorghum straw is used as a filler.

dairy production. This feed is sold at a low price to livestock producers around Wad Medani and it often caused digestive disturbances and some fatalities were reported. It was, therefore, rejected by livestock producers and owners in the area, which created a serious marketing problem for Kabaroo feeds.

IDENTIFICATION OF THE BENEFICIARY AND PRODUCTION-ASSOCIATED PROBLEMS

Private Feedlot Operators

Survey

An informal survey was carried out where 10 of the 80 private feedlot operators around Wad Medani were interviewed. These 10 were selected at random after an initial visit to all feedlots. The operators expressed their willingness to cooperate because they were interested in cheaper diets. Several questions were asked in the interview including:

(a) What is the average number of cattle fed in each feedlot in each feeding cycle? What is the origin of the cattle, mode of transportation, and condition of cattle upon arrival?

(b) What is the purchase price and how long do cattle stay in the feedlot before being ready for market?

(c) Do you sell your cattle to the local market or to merchants who export them? Do you export cattle yourself?

(d) What are the feeds that you usually give your cattle? Do you always use them? What makes you decide on the type of feed? Do you receive any subsidies or free services? Do you use any supplements (minerals, etc.)?

(e) What are the methods used for assessing the degree of finishing or how do you judge that the animal is ready for the market? Do you sell on a weight basis? Do you feel that you are making a decent margin of profit? If no, what are the problems?

(f) Do you use any measures for disease control and prevention (infectious diseases, internal and external parasites, skin diseases, etc.)?

(g) Do you feel that you need to try a new diet if we are able to suggest diets and if the incentive is there and are you willing to use your own resources to try?

Survey Results

(a) Most of the feedlot owners' cattle originate from western Sudan. About 80% are from Darfur and 20% are from Kordofan. One of the producers uses only Kordofan (Rahad) cattle. The size of the herd ranges from between 60 and 90, however, most of them have 80 cattle in their lots.

(b) None of the producers was willing to tell the purchase price, however, nearly all talked about costs and duties. Cattle stay in the feedlot between 60 and 90 days and some up to 109 days. However, some are slaughtered directly off the range, especially when the pasture is plentiful. Even those slaughtered off the range require a resting period of 10-15 days during which they are fed on cottonseed cake and dura.

(c) Most of the producers sell to the local market in Wad Medani and Omdurman. Some have connections with merchants who export cattle to the Arab countries. Invariably, wherever the local market demand decreases, they sell to the Omdurman market, however, no one exports his own cattle directly.

(d) Cattle feed includes a blend of dura and cottonseed cakes. Nearly all feed contains cottonseed as the protein supplement. The proportions vary, with some feeds at a mixture of 50% each and others at 60% cake. Another group prefers a blend of grains, cottonseed cakes, and wheat bran. However, few use straight cottonseed cakes. In all feedlots, sorghum straw was used as a filler, but groundnut hull is also used. No attention was given to mineral nutrition. In only a very few cases is common salt occasionally used. No subsidies or free services of any kind are given. The only free thing is the water of the Nile to which they transport their cattle a distance of 5-7 km twice a day.

The assessment of finishing was done subjectively through the observance of the physical condition of the animal. When the flank becomes full, the hind legs are wide apart, the round and brisket are full and smooth, and the coat is glistening the animal is considered to be "ready." The producers sometimes, however, keep their cattle for an extended period until the market prices are favourable. If this additional period is overly extended, they operate at a loss. When the question of profit was discussed most say "Alhumdullilah" (thanks Allah). However, frequently they operate at a loss because grain prices often rise unexpectedly. In addition, the export of cakes adversely affects their profit margin through reduced accessibility to the cakes for finishing cattle. In these circumstances, they tried molasses and urea, blending it with dura, bran, or hulls and cakes. However, they do not like to use this because handling molasses is difficult and in a few cases excessive fermentation has led to herd loss. They also mentioned that they do not know how much urea to use in the feed. Some tried Kabaroo feed and rejected it, even though it is inexpensive, because it caused digestive disturbances and some claimed that it caused the death of some of their cattle.

Cattle are sold as a group or individually through mutual agreement by subjective evaluation and not on a liveweight basis. Producers did admit, however, that weighing could be helpful sometimes.

Cattle are vaccinated against infectious diseases, although some operators do not wish to vaccinate at this stage. Some vaccinate for one or two diseases, especially when other vaccines were not available. None of the producers treated his cattle against ticks, but some treated skin diseases because the finished animal did not look good.

Kabaroo Feed

The available daily by-products of flour milling that are utilized by the Kabaroo feed mill are (a) 0.27 ± 0.04 t of wheat-grain reject, (b) 15.7 ± 0.55 t of wheat bran, with other by-products being sold to animal owners directly without processing. The amount of by-products depends on the quality of wheat. Wheat is bought from the local market and milled throughout the year except during June-August when imported wheat is used for milling.

In addition to wheat by-products, the Kabaroo feed includes other ingredients (Table 1). The capacity of the mill is 5 t/hour and it produces 5840 t/year. They have in store 2400 t that never find a market. At present, Kabaroo goes into production whenever there is an order for a known quantity of feed. The feed mill produces a broad-spectrum diet that is claimed to be suitable for various production functions such as milk production and growing/finishing cattle and sheep. Chemically speaking, the diet may be suitable for growing/finishing cattle according to the National Research Council (NRC) (NRC 1976) guidelines (Table 2), however, the diet has been rejected by feedlot operators and has only found limited success with the dairy producer, in spite of the available credit system. The diet causes digestive disturbances and metabolic disorders because of the high amount of fermentable carbohydrates and bran. The Kabaroo diet is prepared

Table 2. Nutrient content of different diets (percentage of dry matter).[a]

Diet	CP	TDN	Ca	P
Kabaroo	16	70	0.8	0.6
Suggested warming-up diet	16	60	0.9	0.8
Actual warming-up diet	17	67	0.9	0.8
Finishing diet	15	71	0.9	0.4
Producer's diet	21	54	0.3	0.4
National Research Council (NRC)	10.4	77	0.3	0.25

Note: CP = crude protein, TDN = total digestible nutrients, Ca = calcium, P = phosphorus.

[a] Assuming that 1% NaCl in the diet, with the exception of the producer's diet, satisfied the requirements for these minerals.

in a pelleted form of 2 cm in diameter, which is large for cattle. Kabaroo feed, therefore, faces a serious marketing problem and the owners are concerned.

There are clearly two sets of problems: (a) finding a suitable economical diet for livestock producers that can capture their interest as a viable alternative to the expensive diets based on grains and cakes, and (b) the marketing problem for Kabaroo feeds.

OBJECTIVES OF THE RESEARCH AND APPROACH

Objectives

The major objective of this work is to suggest and test a new, nutritional, but inexpensive, diet for the feedlot operators that will offer an alternative to the diets based on grains, which are difficult to obtain and expensive for cattle feeding. The second objective was to evaluate the Kabaroo feed and try to improve it to increase its sale and to formulate new diets that can capitalize on the milling by-products and fetch a better market price than the old diet.

Approach

After the informal survey, four out of the 10 feedlot operators expressed interest in the trials and they were, therefore, approached. After briefing them about the objectives of the work and discussing possible incentives, such as getting a diet at cost price, two decided to try it. The Kabaroo mill was also approached and an initial agreement was reached:

(a) The team (which is composed of an animal nutritionist and a feed-processing senior student) should suggest an improvement for the existing diet (2400 t).

(b) The team should suggest new alternative diets that the Kabaroo mill could process and sell to the producers at the lowest price possible.

(c) The producer, if he finds the diet satisfactory, will order 100 t at a 10% discount.

(d) The team, through personal contact, will make arrangements so the producer can buy cakes, sorghum grains, and brans for the trials at a reasonable price.

(e) Half of the cattle will be fed a diet blended by the producer and the other half will be fed the newly suggested diets for a period of 90 days.

Protocol

Formulation of the New Diet

Realizing the fact that range cattle when admitted to the feedlot experience a period of compensatory gain before fattening, a warming-up diet was suggested that would be high in proteins, >16% crude protein (CP) and low in energy, <60% total digestible nutrients (TDN), while the finishing diet would provide <15% CP and >70% TDN. Initially, the warming-up diet was suggested to have 10% sorghum straw in it, however, the straw crusher broke and instead the diet has an additional

10% of bran (actual warming up). The suggested warming-up and actual warming-up and finishing diet are presented in Table 1 and diet composition is presented in Table 2.

For the feedlot operators' diets, the producer blended his own diet and fed it to half of the group. Table 1 gives the composition of the operators' diet.

Randomization of Diets to Experimental Animals

The herd was divided into two similar groups (30 animals each) by the team and the feedlot operator. Care was exercised to ensure that there were two groups who were at a similar starting condition. Evaluation was done subjectively by the operator only. The operators' diet and the experimental diets were assigned at random to the two groups. The two groups were separated and no mixing was allowed. Each group was allowed access to water and a liberal amount of sorghum stalks. The cattle were housed on a bare piece of land, near a water canal, with no provision for shade.

Measurements of Intake and Degree of Finish

A total of 22 t from the new diets were purchased by each producer from the Kabaroo feed mill. The operators' diet was blended and weighed. Cattle were group fed at the rate of 6 kg/head per day. A liberal amount of sorghum straw (not weighed) was given as well as free access to water. The degree of finishing was assessed subjectively using the feedlot operators' experience and perception. Subjective evaluation (visual appraisal) was the criterion used by the feedlot operators in the area to assess the degree of finish.

FINDINGS

One of the producers, after purchasing 22 t of the new diet, decided to quit. This report concentrates on one producer who continued in the experiment. Initially, the new diet was not accepted by cattle but, gradually, after 10 days, they got used to it. During the first week, minor bloat was experienced by 10% of the cattle on the new diets, but they recovered quickly. After the warming-up diet was fed during the first

45 days, cattle were switched to the finishing diet. Feeding on this diet continued for another 45 days at the end of which cattle were "ready." Cattle on the operators' diet were ready after 65 days from the start of the experiment. However, the cost of feeding the new diets is substantially less than the operators' diet (Table 3). The operator bought an additional 100 t from the warming-up diet. No statistical analysis was possible.

Improvement of Kabaroo Feed

An improvement trial took place at the University of Gezira to dilute the high amounts of wheat bran and

Table 3. Comparison of per head cost of feeding between the new diet and the operators' diet (in Sudanese pounds (SDP)).[a]

	New diet	Operators' diet
Cost/kg		
Warming-up diet	0.20	0.40
Finishing diet	0.22	
Intake/animal per day (kg)	6	6
Days on feed		
Warming-up diet	45	65
Finishing diet	45	
Total cost of feed over the feeding period	113.4	175.5

Note: This table shows the cost of feeding only; however, those on the new diets were fed sorghum straw for another 25 days during finishing at a cost of SDP 7.5.

[a] SDP 3 = US$1.

wheat grain rejects in the diet. The diet resulting from this process will be referred to as the supplemented diet. In the first phase of the dilution process, 9% groundnut cake and 1% bone meal were added to 90% of the original diet. In the second phase, 15% groundnut straw, 3.5% groundnut cake, 1% bone meal, and 0.5% salt were added to 80% of the diet that resulted from the first phase. The formula of the supplemented diet consisted of 10.8% cottonseed cake, 10.7% groundnut cake, 36% wheat bran, 18% wheat grain rejects, 15% groundnut straws, 6.5% molasses, 2% bone meal, and 1% salt.

The dilution process results in reduction of the percentage of the fermentable carbohydrates to 50.5% of the diet. The Qoz Kabaroo diet was in form of pellets (2-cm diameter). These pellets, as mentioned earlier, were large for cattle and resulted in reduced intake. In addition, when the diet is supplemented, as described above, and fed to growing/finishing crossbred calves, selective intake took place with the result that the supplemented materials were eaten and the pellets were rejected. To solve this problem, the study suggests that, either the whole stored stock (2400 t) be supplemented, reground, or repelleted into smaller-diameter pellets (1-cm diameter). The other alternative is to sell the stored stock at a lower price if a market can be found.

Future Research and Demonstrations in Private Feedlots

After the completion of work in the first year, the findings were discussed at a meeting that included the Kabaroo feedmill manager, the feedlot operator, and the research team. It was agreed that the trials should be assessed more critically through feedlot performance data (intake, rate of gain, feed conversion efficiency, and carcass characteristics). However, because of the drought that so seriously affected the natural cattle-producing areas, cattle owners started to sell their cattle. This significant supply of cattle affected beef prices and, hence, the feedlots did not operate on time. A new feeding strategy was then developed. A system for "storing" cattle on agricultural by-products was suggested. The feedlot operators' cattle were driven for the first time to the Rahad Agricultural

Irrigated Scheme. Arrangements were made to buy the groundnut residues and sorghum straw. The cotton fields were grazed at no charge after the cotton had been picked. Three more producers joined in. Grain feeding is now prohibited by law because sorghum grains are badly needed for the human population. The trials will continue after the appropriate storage period and arrangements are made with the Kabaroo feed mill. Diets will be evaluated more critically using objective measurements of animal performance.

Acknowledgments

Thanks are due to feedlot operator Salih Ahmed Mohamed for cooperation in this study and to the Chairman of the Board of Directors of the Gezira and El managil Tenants Union, Sayed Abdel Galil Hassan, for encouragement. Special thanks are extended to Sayed Afif and Mustafa Faris of the Kabaroo feed mill for their interest in the study and their cooperation. We are indebted to senior animal science students Khadiga Mohammed Elamin and Abbas Adam for their help during the preparation of the manuscript. Special thanks are due to Ilham Abdelrahman for her interest and help throughout the experiment. The efforts of Salwa Abuobieda in typing the manuscript are also acknowledged.

REFERENCES

AOAD (Arab Organization for Agricultural Development). 1982. Feasibility study for a feedlot complex project in western Omdurman, Sudan. Khartoum, Sudan, AOAD.

NRC (National Research Council). 1976. Nutrient requirements for beef cattle. Washington, DC, USA, National Academy of Sciences.

Methodological Summaries

DEFINITION OF RESEARCH PROBLEMS

H.C. Knipscheer

Livestock on-farm trials (LOFTs) are neither ends in themselves nor are they the only means to study farmers' problems or possible improvements in a farming system. Furthermore, LOFTs are clearly inappropriate for addressing many classes of problems. Thus, our emphasis on on-farm trials will necessarily limit the scope of problems we can address here.

Not only scientists conduct on-farm trials, but also extension agents, development officers, and, above all, the farmers themselves. The persons and agencies involved in livestock on-farm trials tend to influence the kind of problems perceived and the type of trials conducted. The papers prepared for this workshop can be roughly divided into four groups on the basis of problem perception: by farmers, by government, by researchers, and "by no one." This categorization is by no means exclusive or even complete.

First, there are on-farm trials that address the farmers' felt needs. Ideally, the scientist tries to be as responsive as possible to the farmers' needs, identifying strongly with them or their families. An example of this approach is ILCA's work in southwest Nigeria. However, by being as responsive as possible, the scientists might find themselves outside their research mandate. The research on improving feed availability during the dry season might be a less controversial example of a research problem that fits the farmers' needs (as perceived by them).

One of the major disadvantages of relying on farmers' perceptions is their lack of knowledge about research possibilities (and limitations) and their possible inability to foresee upcoming problems (such as soil degradation) or future options (e.g., access to new markets).

Second, several papers addressed problems that are perceived by the government (often in collaboration with development agencies) and form the basis of government projects. The dairy production study in Sudan might fall into this category as well as the study of straw treatment with ammonia and urea in Egypt.

The use of on-farm trials in government projects raises a number of issues. Are these really on-farm trials or just a measurement of farmers' responses to a given (and maybe fixed) technology as part of an overall project evaluation? In the discussion about the pros and cons of a linkage between livestock on-farm trials and government development projects, several advantages were noted. On-farm trials as components in a development project may have good chances of success because (a) there is long-lasting commitment to the target area or population, (b) there is often technical and logistical support available, and (c) an extension follow-up becomes more likely. The last point may help satisfy the rising expectations of cooperating farmers. On the other hand, government development projects sometimes promote preconceived technologies that may not be tuned to local conditions and never properly tested. Project authorities, if reluctant to redesign recommendations, might frustrate research efforts. Differences between project and farmers' objectives might bias their responses or affect the farmers' willingness to collaborate. In the case of heavy government input and price subsidies, the on-farm evaluation might yield only temporary results that only last for as long as the government is able to maintain its support. Routine use of on-farm trials for monitoring and evaluation within development projects might offer the best chance to minimize inefficient use of national resources.

A third category of problems addressed are those that do not originate with farmers and are neither associated with government policy nor development projects but are perceived by the scientists themselves. The dual-purpose goat research program in Kenya is geared to overcome an animal protein deficiency in the local diet. The problem of low priority of use of agroindustrial by-products in the Sudan may also be included in this category. Scientists have the advantage of being familiar with the available research capacity, but have a tendency to let the existing research facilities determine the research topic (e.g., unending feed trials) as well as the research method.

The last group of problems could be the most interesting one: those that do not yet exist. Here the purpose of the on-farm trial is to do some (research) activity in association with the farmers to understand better their farming systems and to identify their problems. In this respect, problem identification is a process. Initially, scientists operate from a general problem statement, and subsequently define and redefine the problem(s) in more specific terms. An example is the placing of a sentinel herd with transhumants in Sudan. Indeed, often the most valuable product of on-farm trials might be a better understanding of the management constraints. The feedlot trials in Khartoum identified animal health problems previously undetected. The severe lack of knowledge by scientists regarding farmers' practices within their research mandate is probably one of the prime justifications for on-farm research.

It should be noted that on-farm trials are not necessarily the best tool to meet any of the above research problems. In some cases, an ex ante or a priori evaluation (for example, by partial budgeting or by discussions with farmers) might lead to a redesign of the trial, more station work, or even deletion of the technology from the research agenda. Careful screening of technologies before conducting on-farm experiments results in better use of scarce research resources.

TYPES OF TRIALS

Generally, three types of on-farm trials have been distinguished: (a) researcher-managed trials, (b) farmer-managed trials, and (c) promotional trials (demonstrations). Researcher-managed trials are generally limited to the measurement of only technical parameters. The mineral supplement feeding trial in west Java is an example. The measurement of farmer-managed trials includes behavioural parameters that might lead to "spontaneous treatments" or technical modifications. Farmers experimenting with alley cropping in southwest Nigeria tried burning, tractor plowing, alternative crops, and establishment of alleys in shade. All but the last "treatment" proved satisfactory.

During promotion trials or demonstrations, only farmers' responses are measured. The technological package is fairly strictly defined, and only marginal modifications (fine-tuning) are possible.

TARGET GROUP OR AREA

There is more than one approach in farming-systems research, but all seem to have the definition of a target group or area in common (for example, an ecological zone). Examples of target groups in livestock on-farm trials are the west Javanese and western Nigerian small-ruminant farmers in the SR-CRSP and ILCA programs, respectively, and the oxenholders in Ethiopia. The Rahad Agricultural Scheme in Sudan is an example of a specified target area.

Nevertheless, the lack of target-group definition should be of concern. In many cases, the target group (or recommendation domain) is defined after a (preliminary) technology is developed. Potential users of that technology are then identified if not chased. The "target group" is thus supposed to fit the technology rather than the other way around. The on-farm hay trial in Sudan is a good example. The transhumants were originally part of the "target group." However, after 1 year it became clear that hay making was not an appropriate technology for them, and the transhumants were dropped from the "target group." This does not imply that an important part of the whole research program is not devoted to their problems. Again, the late or hazy definition of "target group" might lead to the waste of research resources, as scientists might continue developing technologies for which only an imaginary target group exists.

Within target groups, the prime actors should be defined. These will depend on the kind of technology tested. For example, in some cases husbands will be the target group, in others, wives, owners, tenants, or even children will need to be contacted. Farming is an activity undertaken by all members of the household.

A clear definition of the research problem, the target population, and the trials' purpose and objectives provides the basis for specification of the on-farm trial design, the level of farmer participation, and the criteria for evaluation of results. These aspects legitimately vary from trial to trial according to the particular problem definition and statement of trial objectives.

ON-FARM TRIAL DESIGN

J.E. van Eys

Design and procedures used for experiments on research stations are often not applicable to the highly variable on-farm conditions. The lack of control and complexity of the farm situation forces experimenters to seek a compromise in rigidity of the experimental design to meet practical requirements on the one hand and precision on the other.

In their efforts to seek more control and facilitate the interpretation of research results, researchers recognize that essential information on farm and production conditions must be gathered. The loss in experimental rigidity can then be compensated for by increased knowledge about variables affecting the response. A diagnostic or in-depth descriptive phase is generally considered necessary and has become routine for many on-farm trials. Results of this survey are used in the selection of locations and farms and the development of suitable experimental designs.

SITE AND FARM SELECTION

The selection of one or more research locations is the first step in livestock on-farm trials (LOFTs). It is realized that such sites should ideally be representative of specific agroecological conditions and the production system of the target farms. Representativeness in these aspects is difficult to define, and in practice the choice is often determined by alternative but equally strong arguments such as farmers' attitudes, reduction in cost, accessibility, and potential for control and supervision over the trial and institutional cooperation (e.g., extension service, government officials). It is questionable if any site can be selected on purely objective criteria alone. Selection of sites on the basis of the above subjective criteria does not necessarily invalidate the research.

Except for extreme situations, the problems that LOFTs seek to solve are unlikely to be location specific and are normally of sufficiently general character that they are applicable to a relatively large region. Furthermore, the gain in farmers' collaboration and experimental control outweigh to a considerable degree the value of selecting a site on characteristics of representativeness.

Farm or farmer selection is not unlike site selection. Complete random, or systematic random, sampling within a location is seldom possible. Criteria that may preclude true random selection are

(a) Willingness of farmers to cooperate and possibly adopt a successful technological innovation;

(b) Criteria for inclusion in the target group;

(c) Relevancy of the research problem to the farmer; and

(d) Suitability of farms for inclusion in the experimental design. The farm should meet the specific requirements of the experimental design in terms of balancing the design or number of replications.

Additional considerations in farmer selection are social standing of farmers in the community, access to the man or woman in charge of the production process of interest, perennial interest in research results, and previous involvement in LOFTs. Consequently, survey information is necessary and must be taken into consideration in the selection process.

From the farmers' points of view, the perceived benefits of participating in a LOFT are evaluated against the risks. Willingness of the farmer to cooperate implies the recognition of the fact that he may benefit from the experiment or at least will not suffer a loss. Expected benefits may be in the form of future applications of the new technology in which case farmers recognize that their enterprise has a solvable problem. Alternatively, farmers may expect to benefit sufficiently from the incentives or compensations provided by the researcher or the prestige associated with the LOFT. In their current concept, LOFTs generally exclude conservative farmers, farmers with marginal enterprises, or those who have had negative LOFT experiences.

The use of incentives or compensations is a common component of LOFTs and an important consideration in farm selection. Compensation for the risk taken by the collaborating livestock producer can take the form of feed, animals, labour, harvest, cash, etc. Monetary compensations should generally be avoided. Incentives may lead to an atypical sample of the farm community particularly if the above-mentioned criteria for farm selection are taken into consideration. As is the case in site selection, however, new technologies are mostly concerned with general techniques or systems. The research problem is never farm specific and results should be applicable under a wide range of conditions.

EXPERIMENTAL CONTROL

LOFTs are generally carried out jointly by farmers and researchers. The degree of control by either party may vary. Although experimental control is likely to be greater under the supervision of the researcher, trials or aspects of trials under the responsibility of the farmer are likely to be of greater relevance to the farm situation.

LOFTs are by definition strongly producer oriented and are carried out under the premise that (a) they primarily benefit the producer through improvements in techniques and productivity, (b) the new technology can be carried out by the producer and fits into his system, and (c) the farmer must be able to evaluate results and recognize applicability and potential benefits. Furthermore, the producer is generally the major investor in the trials on his farm. These are strong arguments for a large producer involvement in the decision-making and control. In reality farmers' inputs, especially at the design stage, are often limited. Low farmer input in the experimental design is likely to remain so as long as farmers have to rely on researchers for problem identification and introduction of new technologies.

Following the initiation of the LOFT, researcher control tends to decrease as producers become more familiar with procedures and recognize the potential importance of the intervention. Ideally, LOFTs progress over time from researcher-managed, to jointly, and, finally, to farmer-managed experiments. This gradual progression is often hampered by the researcher's reluctance to relinquish control and his lack of confidence in the farmers' capacity or willingness to follow research protocols. This situation can at least in part be corrected by regular checking and increased farmer-researcher contact. Researcher trials are characterized by designs aimed at reducing variability due to exogenous factors and the intention to demonstrate significant effects of the experimental treatments. With increased control by producers, farm-specific conditions are allowed to play a more dominant role resulting in increased variability. The objectives for, and the evaluation criteria of, the LOFTs need to be adjusted for this change in management.

As in the case of on-station trials, LOFTs generally include experimental controls. However, they have the advantage of having access to extensive secondary information from surveys that can be used in the evaluation of results or the identification of the effects of the new technology on associated farm activities. Nonparticipating farms may serve as controls if sufficient relevant information on these farms can be collected.

TREATMENT SPECIFICATION

By definition, on-farm trials should seek practical solutions to existing problems. LOFTs must be designed so that farmers can evaluate the impact of the new technology. Design and treatments must be well defined leading to clear and readily interpretable results. The existence of a wide range of interfering factors and large variability within farms questions the usefulness of complex designs. Single-factor experiments are probably most effective. Where additional factors are to be studied, parallel or sequential experiments should be considered. Because of seasonal and climatic effects, most trials should be designed to evaluate the experimental treatments in different seasons. Long-term trials may need to be considered if large climatic fluctuations occur between years.

Treatments that can be incorporated in the design are ultimately limited by the number of replications needed or the sample size. In LOFTs, sample sizes range widely reflecting to some extent the different approaches taken by the various research groups. No specific recommendations can be made because the size of the sample is strictly dependent on the variable to be measured.

In the case of quantitative biological measurements where statistical analysis is often considered important, the sample size is determined by the variability associated with the variable of interest and the desired level of confidence. For such measurements, calculated sample size can become excessively large and impractical. However, in LOFTs, statistical procedures are not always necessary or meaningful. Observations of a survey character, in particular those considering widely established practices, can often be made with adequate confidence on a small sample. In extreme cases, a simple observation may be adequate. A similar situation exists for LOFTs that have reached the demonstration or adoption stage. At this stage, the need for statistical analysis and, therefore, sample size is limited due to the increased concern with the farming system as a whole.

LOFTs that use small herds or flocks may consider applying a single treatment per farm. This generally limits the number of treatments to one per location. The application of more than one treatment per location is only feasible if farmers are not informed or cannot immediately observe the treatments and their effects. Such trials are rare and are limited to experiments under researcher control aimed at extracting more information than absolutely necessary to solve a farmer's problem.

Treatments in LOFTs are generally specified by the researcher on the basis of on-station results or information collected during the diagnostic phase. If treatments are not clearly defined, farmers will interpret or modify treatments according to their own requirements. Application of treatments by farmers may distract the experiment from the original purpose but may provide valuable information and give indications of how new technologies can fit into the existing farming system. Such LOFTs do not generally allow statistical analysis.

LOGISTICS AND COSTS

Costs for on-farm research are closely associated with the experimental design and trial location. Major expenses are in the form of transport costs and requirements for researchers' or farmers' time and resources. Cost factors are important considerations in the selection of study sites and number of farmers. To reduce expenditures due to travel, research locations are frequently clustered in one or two specific regions.

Relative to on-station trials, animal experiments on farms are likely to be less expensive for the research institute. The use of farmers' resources, such as animals, feeds, land, and labour, decreases the cost of station research. These savings are partially offset by the sample size and costs for incentives, compensations, and travel.

To reduce costs of LOFTs, the need is for simplicity in design, such as limited treatment numbers and readily measurable effects. Much of these savings are lost by the need for extensive observations often in excess of 1 year. The inherent large variability and, consequently, larger sample size will further limit possible benefits. Introduction of more than a single treatment may increase cost efficiency but this benefit has to be weighed against the loss in experimental efficiency. The information obtained during the diagnostic phase may be of importance here. Survey work may be one of the more efficient aspects of on-farm trial activities. Reducing frequency of researcher-farmer contact will reduce expenses but at the same time lower the quality of LOFTs.

LEVELS OF FARMER PARTICIPATION

J.A. Kategile

The very existence of a livestock on-farm trial (LOFT) implies the participation of farmers. The rationale for their participation includes:

(a) LOFTs utilize farmers' resources (buildings, land, animals, and other inputs). It is important to identify the activities on the farm with the respective farmers. Self-confidence builds through this practice.

(b) Because LOFTs aim at enhancing technology transfer, the direct contact of the farmer with the technology facilitates this process. When farmers participate in LOFTs, they appreciate the reasoning behind the experiments and can assist in convincing the neighbours of the merits of the technologies being tested.

(c) Livestock keepers are generally unwilling to allow others to handle their livestock. They know that there are some poor managers and some superstitions exist in which they associate poor animal performance with certain clans or families. Examples have been cited in the workshop where herdsmen did not trust scientists initially.

(d) The production levels obtained with farmer participation indicate a more realistic potential of improvement than those from technologies generated in research stations.

On-station scientists, however, are more familiar with prescribed research protocols prepared on standard formats in which the instructions are given to technicians for execution. Other supporting staff (laboratory assistants and labourers) are also used to research protocols such as sampling procedures and sample processing. The line of command is understood and operative and this ensures good-quality research. Research activities are traditionally viewed as belonging to the respective researchers, and it is the responsibility of the researcher to identify people who will assist him. Therefore, a prerequisite to farmers' participation is likely to lower the quality of research.

Farmers are not used to elaborate research protocols and may not see the importance of these strict protocols. At times, a farmer may be tempted to abandon treatments that result in low performance of animals (e.g., a control unsupplemented vs a supplemented group producing significant quantities of milk). The farmers know animals individually and may not like to see some of their good animals receiving inferior treatments. The farmers may also not appreciate long-term experiments (e.g., cow/calf operations vs steer fattening).

On the whole, one should expect a relatively poor precision and low production levels in research work involving farmers, but the results reflect the realistic potential yield responses to technology adoption. Such data should be used in development planning. Further, farmers participation can also show the social acceptance of the technology. With time, more agricultural scientists are taking the challenge in investigating the potential of production in the various socioeconomic environments. For this to be fruitful, it is important that scientists develop a working relationship with farmers at various stages of the LOFT research process.

FARMER PARTICIPATION IN ON-FARM TRIALS

Diagnostic Survey Stage

It is imperative that the scientist-farmer working relationship is developed and nurtured in several stages. Because livestock keepers are skeptical of the skills of others in livestock management, a research team should try to gain the confidence of the farmers during the survey study. Research staff should demonstrate, practically, that they know and can work with livestock; for example, in the treatment of common diseases, watering, milking, and general management.

It is also important to share with them their concerns, and these are usually included as constraints or attributes. The research team should appreciate the farmers' capabilities and skills and give credit where due.

Design Stage

During the design stage the research team should discuss with the farmers the potential usefulness of LOFT in solving the farmers' problems. The drawbacks and the problems associated with LOFT should also be highlighted. Farmers should be given a chance to indicate their aspirations, some of which could be incorporated in the design of the experiments. For example, if the farmers feel strongly that one way of increasing milk production is through introducing improved breeds rather than improved feeding per se one may wish to include this in the design, although it may not have been in the original plans.

During the design stage, researchers should discuss LOFT objectives and plans in detail with the farmers specifying the total needs for LOFT and the expected contribution from the farmers in the form of facilities (housing, watering, land) and inputs (feeds, veterinary drugs, labour). It is important to avoid excessive demands on farmers' resources and, similarly, scientists should avoid excessive commitments and eliminate luxurious external inputs that the farmer cannot afford after the experiments are phased out. Data on household income and disposal should be used in planning the level of external farm inputs. The issues of protection against risks should be discussed as well as compensation and incentives for the farmers. The forms of agreement, whether verbal or written, are to be discussed at this point.

The schedule of LOFT activities has to be discussed in detail with the farmers. They can then identify areas where they could participate without affecting their routine production activities and areas where they will need assistance. For example, if the planting time for improved pastures coincides with the planting time for food crops, the farmer may need assistance. Details have to be worked out, carefully ensuring farmer participation but not at the expense of his other routine work. The researcher should be convinced that farmers are part of the research team. Farmers should not be used as labourers for LOFTs but as colleagues.

Implementation of LOFT

The importance of farmer participation in the whole process of transfer of technology has been mentioned earlier. One should try as much as possible to follow the design and schedule of activities agreed upon with the farmers during the design stage.

To enable the farmers to participate usefully in LOFT, the farmer has to be trained and guided in research protocols, but this may be a slow process and requires patience. Some of the specific tasks such as allotment of animals into experimental groups and sampling may require continued direct involvement of the researchers. Measurements of inputs and parameters should be simplified for the farmers' use. For example, calibrated volumetric containers can be used for measuring concentrate feeds or milk yields. Simplified record forms (weekly or calendar-day sheets) can be adapted and filled in by the farmers. Complicated forms are unsuitable.

When farmers are asked to manage a LOFT, this demands time and takes them away from their routine work so there may be a need for recruiting replacement labour. This should be worked out carefully.

Appraisals

Farmers who are managing LOFTs continually assess the treatment effects because they note differences in the condition or performance of their animals. Researchers should encourage farmers to give their opinions on the treatments. Correct farmers' appraisals should be reinforced, whereas incorrect interpretations should be carefully realigned. Copies of simple summaries of data from the LOFT should be given to farmers. When studies reach an advanced stage of confirmation, researchers may use the farmers in spreading the appropriate technologies. The possibility of organizing field days among cooperating farmers should be explored as it enhances exchange of experiences. Similarly, formal appraisals may be instituted at intervals. Appraisals of LOFTs should be comprehensive and should include the opinion of other groups, such as extension workers and policymakers.

Terms of Agreement

It is important to recognize the special roles of livestock in small farms when one is discussing agreements with farmers on the use of livestock for LOFT. To farmers, livestock are an investment (bank account, bonds, or capital goods), food for the family (goats, sheep), an insurance against crop failures (in dryland areas, livestock ensure survival through droughts), an old age insurance (the aged depend more on livestock than arable cropping), units of social hierarchy, and social values (bride price, social functions).

The significance of any of these values varies with societies and societal groupings. In general, one can say that livestock keepers in the dryland areas are more dependent on, or more attached to, livestock and are less likely to enter into an agreement on the use of livestock for LOFT.

On the whole, it is desirable to take into consideration the farmers' interests and, as far as possible, the livestock keepers should be able to dispose of stock or livestock products for either home consumption or cash income. For example, in dairy enterprises, the farmer should be assured of the right to milk and samples should be small. If farmers' herds are large, one should exclude the stock that are likely to be disposed of on short notice, so a short-term agreement may be desirable.

Because livestock keepers obtain consumable livestock products and income from stock, LOFTs should aim at increased livestock productivity. The importance of designing experiments in which the traditional way of management is the control group, has been stressed elsewhere. A fair agreement should guarantee that the treatment groups will do no worse than the control group and, in cases where the treatment groups are relatively poor, fair compensation should be provided for. It is also desirable to pay for any injuries due to handling or deaths in the treatment groups regardless of the cause. Where insurance policies are available, the whole flock or herd should be insured.

An agreement should also protect the farmers from risks of long-term investments, such as capital items (housing, fencing, soil conservation). The agreements should be flexible enough so that the farmer can make changes where necessary and also terminate the agreement if he so chooses.

The form of agreement depends on the locale. In some countries, a gentlemen's verbal agreement is acceptable and honourable, whereas in others the village leaders may be called upon to take witness of the informal agreement but, at the other extreme, a formal agreement drafted by a lawyer is the only acceptable agreement.

REVIEW OF FARMER PARTICIPATION

In the papers presented, farmer participation varied considerably. There are cases where technology testing had reached an extension stage and farmers were given initial technical advice and guidance and allowed to make their own decisions on the design of trials, management of trials, and utilization of the products obtained. In this process, the farmers are able to modify the technological packages and, actually, researchers learn from the farmers' "experimentation." As an example, some of the cooperating farmers in the alley cropping project in Nigeria burned the stubble accumulating between the rows of trees. In the majority of the papers, it was not clear as to whether the farmers participated in the design of on-farm trials. It is, however, indicative that the farmers traditional practices were taken into consideration in the design of the experiments because the traditional method represented the control group. There are a number of cases where farmers' aspirations were taken into consideration during the execution of LOFTs, and the results have usually been positive.

The farmers' contribution to the inputs in the trials varied without exception. They permitted the use of land, houses, livestock, and other facilities (water and feeding facilities). In the case of western Sudan, the Baggara did not allow this use of their cattle for data collection (mutual confidence had not developed). In one case, the researchers had to pay rent for the night enclosures in western Kenya. The provision of experimental animals by the research team was made in situations where the class of stock for the trials formed part of the technological innovations for testing. Scientists on the whole have attempted to involve the farmers in the management of the trials under supervision of the research team. There are, however, only a few cases where farmers were trained to take records. There is a need to get the farmers more involved in this.

The farmers had access to the resulting products and this was very encouraging for them. The farmers' views and opinions on the results of the trials were consistently taken into account, but it is generally unclear as to the influence of incentives and compensation on farmers' opinions. Phasing out inputs provided by the research team can help in getting a more accurate view of the farmers and their reaction to the technologies being tested.

The need for either an informal or formal agreement with the farmer was well recognized and no serious misunderstandings were reported, but it is important to remind scientists about the need to take farmers' interests into account when formulating agreements with them.

It is noted that current activities of LOFT involve the farmers in the diagnostic survey, execution, and evaluation of the experiments. However, farmers' participation has been limited during the design of LOFTs and during continuous appraisal. It is felt that in the future these areas need more emphasis.

CRITERIA FOR EVALUATION

R.H. Cook

The primary objectives of livestock on-farm trials (LOFTs) are to test the appropriateness of production-increasing, cost-reducing technologies and to facilitate the transfer of these technologies to the maximum number of target farmers. Accordingly, the results of livestock on-farm trials should provide researchers with a clear understanding of the technical effectiveness, the economic benefits, and the sociocultural compatibility of potential technologies in the context of the target farming system. Depending on the nature of the technology being tested, its technical complexity, the amount of prescreening, its input requirements, and the characteristics of the production enterprises of the target system, considerable time may be required before all these criteria are sufficiently clarified to recommend extension of the technology. Because of this fact, and the high level of resources frequently required to implement livestock on-farm trials, potential technologies should be critically prescreened and on-farm trial designs and results critically evaluated to maximize the possibilities of extending adoptable interventions to producers in the shortest period of time.

TECHNICAL EFFECTIVENESS

The technical effectiveness of a proposed intervention involves a quantitative and qualitative assessment of both the animal's biological response to a technology and the technical compatibility of the intervention with the resource base of the farming system. In the case of livestock farming systems, many of the production constraints faced by traditional producers are technically based. Levels of livestock productivity in traditional production systems reflect the end result of a number of technical interactions involving a number of input factors, such as: (a) management/husbandry practices, (b) biophysical aspects of the natural resource base, (c) allocation of inputs, (d) disease incidence, and (e) productive potential of the livestock. An assessment of the technical effectiveness of a proposed intervention should, therefore, not only consider changes in output, i.e., animal productivity, but also the impact the technology has on the input resource base.

For livestock, changes in output are frequently equated with a change in productivity (weight gain, parturition interval, milk production, etc.). The likelihood that measurable changes in one or more of these productivity criteria represent a comparative change in the total systems output is determined by the nature of the system (crop/livestock, pastoral, commercial) and the production priorities of the producer.

The reliability of quantitative and qualitative measurements in reflecting a realistic impact on the output from the target system is determined by: (a) the selection and measurement of criteria that reflect the producer's production priorities, (b) the quantitative and qualitative contribution livestock make to the system's total output, (c) biases introduced through the provision of production inputs by researchers, and (d) the precision of measurements and the type of analytical methods used. In addition, consideration must be given to the technical nature and level of required inputs and their availability to the producer on a continuous or seasonal basis.

The long-term success of newly adopted technologies will in part depend on the impact such interventions have on the natural resource base of the target system. Of special importance in the case of pastoral systems, but applicable to all farming systems, are technologies that aim to improve the producer's ability to utilize more efficiently, in a conservationally sound fashion, his natural resources. Such technologies are of considerable importance in attempts to stabilize and improve deteriorating environmental resources. The compatibility of potential technologies with the long-term improvement of the natural resource base is an important factor to be considered when evaluating the technical effectiveness of technologies being assessed in LOFTs.

ECONOMIC BENEFITS

The impact of a technology on the economic resource base of the target farmer is an important criterion in the assessment of livestock on-farm trial results. Economic analyses used in evaluating this impact generally seek to establish potentially quantifiable economic benefits that could accrue to the producer through adoption of a recommended technology. Such technologies should be compatible with the farmers' economic resource base and utilize those resources in a more efficient fashion to maximize their chances for adoption.

Estimation of economic benefits for producers requires a realistic assessment of their economic resources (land, labour, and capital) and a knowledge of how these resources are traditionally allocated among the producers' production enterprises. An understanding of the producers' production priorities is important to enable researchers to select appropriate production parameters (animal sales, milk sales, slaughter for home consumption) to undertake relevant economic analyses. In the case of poor resource farmers, seasonal shortages of cash and labour, such as during planting and harvesting periods, can have important implications for the success of a potential intervention. Understanding the seasonal fluctuations in market prices is important when costing a livestock output. Livestock generally are sold during periods when households need disposable income. In the case of large ruminants such sales can be erratic, depending on need, and undertaken without regard to trends in market prices. An evaluation of input costs also requires consideration of not only seasonal availability but also opportunity costs. These input costs can be high in areas with poor infrastructures, requiring considerable logistical planning and efforts by producers.

Economic analyses must attempt to estimate realistic "farm-gate" prices for both inputs and outputs. Parameters such as profitability, marginal net benefit, benefit/cost ratio, etc. are realistic indicators for researchers to assess the potential economic benefits, provided that efforts have been made to evaluate actual farmer/market interactions.

One important difference between livestock and crop production is the difficulty in quantifing many of the outputs from livestock and ascribing monetary values to them. In these cases, estimating the economic impact of a technology on a farming system must include both economic analysis and formal/informal farmer responses.

SOCIOCULTURAL COMPATIBILITY

The clearest statement of the sociocultural compatibility of a new technology in a farming system is its outright adoption by the farmer who provides all required inputs from his own resources. Measurement of adoption rates is one technique for quantifying system compatibility for a technology. Moreover, deviations from recommended practices, as identified by on-farm monitoring activities, provide important information for researchers to use in adjusting and modifying technologies to "fit" better into a target system.

Evaluation of sociocultural compatibility should not wait until the end of technology testing. Farmer involvement and assessments even in the technology design stages can assist researchers in designing appropriate technologies for target groups. Because one of the primary objectives of LOFTs is to facilitate technology transfer to the farmer in the shortest possible time, the early involvement of both farmers and extension agents is critical. Although farmer assessments are essential to evaluate sociocultural compatibility of a technology, regional and national policymakers can have an important impact on the acceptability of a technology. Accordingly, results of LOFTs should be evaluated within the context of regional and national development priorities. The successful adoption of a technology that is consistent with these goals will have a much greater chance of support. This will enhance the possibility that policies, which will assist farmers in adopting a recommended technology, will be implemented.

CONCLUSION

The three main criteria (technical effectiveness, economic benefits, and sociocultural compatibility) represent broad areas that should be addressed when evaluating the results of on-farm trials. However, not every LOFT may be designed to address all of them concurrently. In the evolution of livestock on-farm trial methodology, early efforts have focused on technology identification under farmer conditions. Such trials have invariably been researcher managed and have focused on evaluating the effectiveness of a potential technology. Perhaps more farmer involvement in this stage of on-farm trials would make technology screening more efficient and more relevant to farmers' conditions.

As livestock production systems become better understood and researchers become more confident of technologies under farmer conditions, livestock on-farm trials will likely move to a management mode with increasing farmer involvement and increasing emphasis on sociocultural criteria, such as adoption rates.

Most of our livestock on-farm trials in this workshop clearly illustrate that we are in the early evolutionary stage of on-farm trial methodology. The challenge will be how fast we, as livestock scientists, can move from an emphasis on researcher technology to an emphasis on farmer adoption.

DIRECTIONS FOR FUTURE TRIALS

Frank M. Anderson

Rapid production gains must be achieved in many of the world's agricultural areas to allow even subsistence needs to be satisfied in the coming decades. Livestock keeping is a common element of most subsistence and low-income farming systems. The evidence available from many cases indicates that significant production gains are both practicable and profitable in these livestock enterprises, especially if the necessary technical packages are tailored to the needs and resources of farmers. By exploiting these opportunities to increase the yields of both intermediate livestock products such as draught power and final products such as meat and milk, farmers will be better able to provide for their basic needs. Conducting on-farm trials with livestock is one potentially potent means of designing and testing appropriate livestock technologies for adoption by farmers to enable this overall production goal to be satisfied.

Livestock on-farm trials (LOFTs) are in their infancy compared with on-farm crop trials. Despite the comparatively few case studies available, the results to date suggest that LOFTs are able to produce results relevant to farmers' needs. To the extent that these trials are efficient users of scarce research funds in the generation of livestock technologies they will compete successfully for at least a part of these funds. However, at this time much of the LOFT research is funded by bilateral and multilateral agencies and by international research institutes. As a result, the trials done with the support of these agencies have not competed with traditional livestock research for the core funds available to national research institutes. Funding from these extra-national agencies has been catalytic in focusing attention on the appropriateness of greater farmer involvement in the design and testing of new livestock technologies. However, they cannot and should not attempt to substitute in the longer term for the research by national agencies in addressing what will increasingly become location-specific research problems. To the extent that LOFTs will become increasingly important as a means of producing relevant livestock technologies, they will need to become accepted as "legitimate" research by national research establishments.

This synthesis highlights some major issues concerning future applications of LOFTs. Successfully addressing these issues will enable LOFTs to become an accepted and routine part of livestock research in national agencies.

A topic of current concern to both observers and practitioners of LOFTs is that the cost of research using the on-farm approach must be less than similar work done in the traditional mode on research stations. This focus on costs has diverted attention from the more important criterion for comparison of the two approaches, namely the comparative impacts on production (benefits) versus the costs of research. Although there are substantial methodological problems in assessing the impact of research (originating from either on-station or on-farm trials), it is important at this stage in the development of LOFTs that this be attempted to enable the case for LOFTs to be more firmly established. Few of the LOFTs to date have sought to estimate benefits accruing to farmers other than for those farmers with whom the trials are conducted. Insofar as the beneficiaries of technical changes in livestock production will also include urban consumers and others through major changes in market prices and supplies, then it will often be appropriate to estimate such impacts as part of the overall assessment of a new technology. Note here that a major advantage of technologies tested on-farm, as opposed to on-station, is the earlier adoption by larger groups of farmers of the farm-tested technologies. Given the urgency to produce change in many production systems, this anticipated advantage of the on-farm approach assumes considerable importance. Assessment of impact is, therefore, a priority task.

Compensation to farmers for participation in LOFTs is another issue of current interest. Many writers draw attention to the need to reduce or even eliminate the risks associated with participation that arise through failure of the technology being tested. Examples of such risks are death of animals in the trials, lost production opportunities when cropland is directed to pasture production, reduced milk yields when livestock are fed inferior rations, and so on. Although production risk is undoubtedly an important consideration in the design and operation of a new technology, it should not be forgotten that farmers already manage their resources and make decisions in an uncertain biological, technical, and economic environment. Agricultural production, including livestock production, is risky.

For this reason, it is not appropriate for farmers to be compensated (usually in a mix of ways) for their participation in on-farm trials of livestock technologies to the extent that there is no risk associated with the trial. Removal of all risks of participation make the results of the LOFTs largely uninterpretable as regards the applicability of the technology to other farmers for whom it is ultimately intended to be delivered. Compensation can take many subtle forms. For example, association with the LOFT can facilitate access to essential farm inputs (including inputs other than those needed for the on-farm trial) or can provide additional security of land tenure. Thus the compensation package for participation in the on-farm trials is often more substantial than would be indicated by a simple summation of the direct physical inputs and advice provided by the research group. As a guideline, it can be argued that apart from special cases, the overall compensation package for participation should not exceed that which could be provided to farmers when the technology is to be delivered to the larger community of farmers by the extension services when the testing phase is completed.

By adopting this guideline, the environment for the LOFTs will match the overall policy environment in which farmers produce. In some instances, and especially for those technologies expected to have a relatively long on-farm testing period, it will be appropriate to offer a compensation package matching the policy environment expected to apply at the time when the technology will be available for general adoption. The compensation issue is complex, but in all instances researchers concerned with LOFTs should avoid seeking early successes in their trials by offering favourable compensation packages, at the likely expense of later failure in adoption by the majority of farmers who will not receive these same benefits. Note also that LOFTs typically require close association between researchers and farmers over a period of years. This contrasts strongly with annual crop trials conducted on farms. For this reason the compensation issue is more important with LOFTs than on-farm crop trials.

Many current LOFTs have their origins in special projects funded by extranational agencies. A major objective of these trials has been to give national researchers the opportunity to gain experience with on-farm research. This strategy has been successful and has performed an important training function for the national researchers concerned. However, because such trials have to some extent been ad hoc and separated from the mainstream of research in the national research agencies, they have usually had a less than ideal involvement of extension officers. Further success of LOFTs will depend importantly upon establishing a close working relationship between the LOFT team and extentionists if the technologies tested are to be made available to the target farming community. Because on-farm trials with livestock are not yet a routine task, the inter-institutional links between the LOFT teams and extension agencies are informal. LOFT research groups will need to take the initiative and seek the regular and close involvement of extensionists in their work beginning at as early a stage in the research as practicable.

The beginnings of training in LOFT methodologies has already been noted. It is important, however, to highlight that more researchers need to be exposed to the approach. Both new recruits to the research establishment and experienced researchers should have a hands-on exposure to LOFTs. The early involvement of both groups will have a positive effect on attitudes toward on-farm trials. Additionally, the on-farm research experience should favour increased relevance of station-based livestock research. Although LOFTs will assume increased prominence in the coming years, there will still be a need to have station facilities available for livestock research. Strengthening the links between on-station and on-farm livestock trials will enhance the effectiveness of the overall research process.

The range of on-farm trials already being done with livestock suggests that, with few exceptions, farms can be the sites for useful livestock trials. The apparent adaptability of many trials to application on the farm may lead to the situation where interventions are tested on-farm when it is not necessary. This would be wasteful of scarce research resources. On-farm trials with a new livestock technology should only be done if they can be expected to provide a clear expected gain in knowledge about the technology over other means of testing. Some researchers think that if the interactions between a particular technology (already tested on a research station) and the farm environment are expected to be of limited importance, it would be appropriate to take the technology directly to the farmer through the usual extension channels. In such a case on-farm testing would seem unnecessary. However, if these technology/environment interactions are likely to be important (elaboration of such effects should be a routine part of prescreening the technology) then it may be appropriate to test it on-farm. All cases will need to be examined separately. Also, in regard to this important link between on-station and on-farm livestock trials, note that not all new technologies will need to be tested on-station before testing on-farm. In many cases, sufficient experience and knowledge will be available to require that on-farm trials only be conducted. The appropriate choice of testing methods and locations will depend importantly upon close and open communication between researchers responsible for the on-station and on-farm trials. Resolution of the potential conflicts in these choices will be facilitated if researchers share responsibilities for both types of trials.

In the future, increased emphasis will need to be placed on prescreening of technologies before their inclusion in tests on farmers' fields. More rigorous prescreening will save scarce research resources, both by enabling inappropriate technologies to be discarded early in the research process, and by producing better designs for those on-farm tests where it is considered they will yield useful information. The design possibilities for complex livestock technologies are typically numerous, and the usefulness of the trial will depend upon the researchers identifying the most appropriate input levels, schedules, and harvest frequencies, for example, which will most likely apply under farmers' management. It is in this sense that "better" designs will result from proper prescreening. A range of prescreening methods is available including the use of partial budgets, whole farm programming models, simulation models of biological or economic subsystems of interest, and other operations research methods. The easy access now possible to powerful microcomputers makes effective prescreening an easier task than was the case even 5 years ago. For example, sensitivity analyses can now be done routinely and quickly allowing the robustness of a technology to be assessed for a range of assumptions about productivity and prices.

LOFTs have to date ranged from simple single-factor trials, to trials requiring inputs of several factors, to trials involving introduction of new enterprises on farms and substantial capital investments. Undoubtedly this variability in the types of trials with livestock will continue to be an important feature of LOFTs. This variability raises the issue of the desirability or otherwise of complexity in such trials. There are no strict guidelines to be followed. In some cases where quantum increases in production are urgently needed it may necessitate complex changes to existing farming systems. Although complexity in the on-farm trials in such instances will undoubtedly make extra demands on researchers (and farmers), it will be unavoidable. In other cases simple changes and correspondingly simple trials will suffice. Over time, however, the opportunity to intervene with "quick fixes" will diminish and generally increased complexity in on-farm trials will be the norm rather than the exception. Complexity, however, has its advantages. Of particular concern in this regard is that complex trials, in turn implying usually complex changes to farming systems, can be designed so that farmers will have some opportunities to tailor the technology to their own circumstances. They will do this by modifying the levels of inputs, for example, or by deleting or adding components to the basic technology they adopt. To the extent that this will be done by farmers, the ultimate target of the results of LOFTs, this opportunity to fine-tune the technology on their own farms, will in part obviate the need to do this formally in researcher managed on-farm trials.

In conclusion, what is the outlook for on-farm trials with livestock? They will become a routine part of national research system activities. The involvement of extra-national agencies will diminish except in a general support role, especially as regards training in the methods involved. To an important extent, the speed with which they become a routine research activity will depend upon effective and efficient execution of the trials now being done and the early implementation by farmers of the results of these trials. If an impact on farming systems can be achieved it will be persuasive and supportive of the case for greater involvement of farmers in the development and testing of livestock technologies.

PARTICIPANTS

Frank M. Anderson, Agricultural Economist, Leader of the Highlands Programme, International Livestock Centre for Africa (ILCA), P.O. Box 5689, Addis Ababa, Ethiopia

Akwesi Atta-Krah, Small Ruminant Programme, International Livestock Centre for Africa (ILCA), PMB 5320, Ibadan, Nigeria

Richard H. Cook, Senior Livestock Production Specialist, Western Sudan Agricultural Research Project/ Kadugli (WSARP), Agricultural Research Corporation, P.O. Box 5141, Khartoum South, Sudan

J.E. van Eys, Department of Animal Science, North Carolina State University, P.O. Box 7621, Raleigh, North Carolina 27695 USA

Babo Fadlalla Mohammed Dafaala, Western Sudan Agricultural Research Project/Kadugli (WSARP), Agricultural Research Corporation, P.O. Box 5141, Khartoum South, Sudan

Mahgoub Gaafar El Hag, Department of Animal Nutrition, Institute of Animal Production, University of Khartoum, P.O. Box 32, Khartoum North, Sudan

Nabil Ibrahim Hassan, Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD), P.O. Box 2440, Damascus, Syria

Charles G. Hickman, Technical Advisor, World Bank Projects, Ministry of Agriculture, Forestry and Rural Affairs, Milli Mudafaa CAD No. 20, Kizilay, Ankara, Turkey

Ersin Istanbulluoglu, Assistant Director General, Project Implementation Directorate, Ministry of Agriculture, Forestry and Rural Affairs, Milli Mudafaa CAD No. 20, Kizilay, Ankara, Turkey

Hendrik C. Knipscheer, Agricultural Economist, Winrock International, Route 3, Morrilton, Arkansas 72110-9537, USA

Rashid S. Modawi, Breeder, Faculty of Agricultural Sciences, University of Gezira, P.O. Box 20, Wad Medani, Sudan

Adrian W. Mukhebi, Farming Systems Economist, Small Ruminant Collaborative Research Support Program (SR-CRSP), P.O. Box 252, Maseno, Kenya

Abdelfattah Y.M. Nour, Head, Department of Animal Science, Faculty of Agricultural Sciences, University of Gezira, P.O. Box 20, Wad Medani, Sudan

Abdel Hamid Osman, Director, Institute of Animal Production, University of Khartoum, P.O. Box 32, Khartoum North, Sudan

James W. Oxley, Director, International Agricultural Programs, Colorado State University, Fort Collins, Colorado 80523, USA

George Primov, Midamerica International Agricultural Consortium (MIAC), Centre Régional de la Recherche Agronomique, P.O. Box 290, Settat, Morocco

Hazem Al Samman, Director, Sheep, Range and Steppe Directorate, Ministry of Agriculture and Agrarian Reform, Damascus, Syria

Ahmed E. Sidahmed, Small Ruminant-Collaborative Research Support Program (SR-CRSP), P.O. Box 252, Maseno, Kenya. (Present address: FAO Expert, Range and Livestock Development Project, c/o UNDP, P.O. Box 358, Tripoli, Libya)

Ismail Soliman, Animal Production Research Institute Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt

Helmy Yackout, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. (Present address: Livestock Specialist, Food and Agriculture Organization of the United Nations (FAO), Beef Project, P.O. Box 1893, Alexandria, Egypt)

ICARDA

P.O. Box 5466, Aleppo, Syria

Mohamed A. Nour, Director General

Awad El Karim Hamid Ahmed, Agricultural Economist, Farming Systems Program (FSP)
Phil Cocks, Leader - PFLP
Peter Cooper, Leader - FSP
Abdul Karim Ferdawi - PFLP
Haitham Halimeh - FSP
Ronald Jaubert, Agricultural Economist - FSP
Salah Magid - FSP
Thomas L. Nordblom, Agricultural Economist - FSP
Mahmoud Oglah - FSP
Ahmed Osman, Agronomist - PFLP
Andrée Rassam - FSP
Abdul Kader Summakieh - FSP
Euan Thomson, Animal Scientist - PFLP
Mohammed Touma - PFLP
Dennis Tully, Anthropologist - FSP

IDRC

Jackson A. Kategile, Program Officer, Eastern and Southern Africa Regional Office, IDRC, P.O. Box 62084, Nairobi, Kenya

K. Kealey-Vallière, Technical Editor, Communications Division, IDRC, P.O. Box 8500, Ottawa, Canada K1G 3H9

Gordon R. Potts, Program Officer (CAPS), Middle East and North Africa Regional Office, IDRC/CRDI, P.O. Box 14 Orman, Giza, Cairo, Egypt

تجعل من عملية التنقية الأولية الفعالة مهمة أكثر سهولة مما كان عليه الحال حتى قبل خمس أعوام. فمثلاً يمكن الآن اجراء تحليل الحساسية بطريقة روتينية وسريعة مما يتيح الفرصة لتقييم قوة التقنية في مواجهة عدة افتراضات للانتاجية والأسعار.

لقد تراوحت التجارب الحقلية للثروة الحيوانية حتى اليوم بين التجارب البسيطة ذات العامل الواحد مروراً بالتجارب التي تتطلب مساهمة عدة عوامل الى التجارب التي اشتملت على ادخال مشروعات جديدة بالحقول واستثمارات ضخمة لرأس المال. وبدون أدنى شك فان هذه المتغيرية في أنواع التجارب على الثروة الحيوانية ستستمر لتكون معلماً هاماً للتجارب الحقلية للثروة الحيوانية. وهذه المتغيرية تثير مسألة الرغبة أو عدمها في التعقيد في مثل هذه التجارب حيث أنه لا يوجد نهج واضح يمكن اتباعه. ففي بعض الحالات التي تمثل فيها الزيادات الكمية في الانتاج مطلباً عاجلاً يمكن أن تصبح التغيرات المعقدة في النظم الزراعية القائمة ضرورية. ورغماً عن أن التعقيد في التجارب الحقلية في مثل هذه الحالات يستوجب بلا شك طلبات اضافية على الباحثين الا أنه لا يمكن تجنبه. وفي حالات أخرى تكفي التغيرات البسيطة وما يصاحبها من اختبارات بسيطة. وبمرور الزمن فان الفرصة للتدخل بـ«اصلاحات عاجلة» تتلاشى ويصبح ازدياد التعقيد في التجارب الحقلية هو القاعدة وليس الاستثناء على وجه العموم. علاوة على ذلك فان للتعقيد مزاياه. وهنالك اهتمام خاص في هذا المجال هو أن التجارب المعقدة — التي توحي بدورها عادة بتغيرات معقدة للنظم الزراعية — يمكن أن تصمم بحيث تتيح بعض الفرص للمزارعين لتكييف التقنية وفقاً لظروفهم. وسيقوم المزارعون بهذا العمل عن طريق تعديل مستويات المدخلات — مثلاً — أو بشطب أو اضافة مكونات الى التقنية الأساسية التي يتبنونها. وطالما أن المزارعين يقومون بهذا العمل — الذي يمثل الهدف النهائي لنتائج التجارب الحقلية على الثروة الحيوانية — فان هذه الفرصة لضبط التقنية على حقولهم تجنبهم الحاجة لأداء هذا العمل بطريقة رسمية في التجارب الحقلية التي يشرف على ادارتها الباحثون.

في الختام، ما هو مستقبل التجارب الحقلية للثروة الحيوانية؟ لاشك انها ستصبح جزءاً روتينياً من نشاطات النظام القومي للبحوث وسيتضاءل اشتراك الوكالات غير القومية الا بالنسبة لدورها العام في الدعم خاصة فيما يتعلق بالتدريب على الطرق المستخدمة. والسرعة التي تصبح بها هذه التجارب نشاطاً بحثياً روتينياً تعتمد بدرجة هامة على إستمرار وفعالية تنفيذ التجارب التي تجري الآن وعلى تطبيق المزارعين المبكر لنتائج هذه التجارب. ولو أمكن تحقيق تأثير على النظم الزراعية فسيكون هذا مقنعاً ومدعماً لفكرة اشتراك المزارعين بدرجة أكبر في تطوير واختبار تقنيات الثروة الحيوانية.

عدا بعض الاستثناءات القليلة . وقد يقود التكيف الظاهري للتطبيق الحقلي لكثير من التجارب الى مواقف يكون قد تم فيها اختبار حقلي للابتكارات فيما غير ضرورة الشيء الذي يمثل تبديداً للموارد البحثية . ويجب ان يتم اجراء التجارب الحقلية للتقنيات الحديثة للثروة الحيوانية فقط اذا كان يتوقع لها أن تحقق مكسباً متوقعاً وواضحاً في معرفة التقنية بالمقارنة مع طرق الاختبار الأخرى . يعتقد بعض الباحثين أنه في حالة توقع أهمية محدودة لتفاعلات بين تقنية معينة تم اختبارها في محطة البحث وبين البيئة الحقلية يكون من الأنسب أخذ التقنية مباشرة الى المزارع عن طريق قنوات الارشاد المعتادة . ففي هذه الحالة لا يكون الأختبار الحقلي مناسباً . غير أنه عند وجود احتمالات لأن تكون التفاعلات بين التقنية والبيئة ذات أهمية (حيث يجب ان يكون تفصيل مثل هذه التأثيرات جزءاً روتينياً للتنقية الأولية للتقنية) يصبح من الأنسب اختبارها في الحقل . وستحتاج كل الحالات لأن تفحص كل على حدة . أيضاً وبالنظر الى هذه الصلة الهامة بين تجارب الثروة الحيوانية التي تجرى بمحطات البحوث وتلك التي تجرى بالحقول يلاحظ أنه ليست كل التقنيات الحديثة بحاجة لأن تختبر في محطة البحث قبل اختبارها في الحقل . ففي العديد من الحالات تتوفر الخبرة الكافية والمعرفة مما يتطلب اجراء التجارب الحقلية فقط . ان الاختيار المناسب لموقع الاختبار يعتمد بدرجة هامة على قرب وانفتاح الاتصال بين الباحثين المسؤولين عن تجارب محطات البحوث وبين رصفائهم المسؤولين عن التجارب الحقلية . واذا تشارك الباحثون مسؤوليات النوعين من التجارب فان هذا يسهل عملية التغلب على التضاربات التي يتوقع حدوثها .

ان عملية التنقية الأولية للتقنيات تحتاج الى المزيد من التركيز في المستقبل وذلك قبل تضمين هذه التقنيات في التجارب على حقول المزارعين اذ أن اجراء التنقية الأولية بدقة شديدة يوفر موارد البحث الشحيحة باستبعاد التقنيات غير المناسبة مبكراً وباعداد تصميمات أفضل لهذه التجارب الحقلية عندما يستشعر أنها ستتمخض عن معلومات مفيدة . ان الاحتمالات التصميمية لتقنيات الثروة الحيوانية المعقدة عديدة بدرجة نموذجية وتعتمد الفائدة من التجربة على تحديد الباحثين لأنسب مستويات المدخلات (البرامج الزمنية وتكررات الحصاد على سبيل المثال) والتي ستكون أكثر قابلية للاستعمال تحت ادارة المزارعين . وبهذا المعنى فان «أفضل» التصميمات تكون نتاجاً للتنقية الأولية المضبوطة . وهنالك طرق عديدة ومتوفرة لاجراء التنقية الأولية وتشمل استعمال الميزانيات الجزئية ونماذج البرمجة الكاملة للحقل والنماذج المقلدة للنظم الفرعية البايولوجية أو الاقتصادية الهامة وطرق بحوث العمليات الأخرى . ان سهولة امكانية استخدام العقول الالكترونية الصغيرة ذات الفعالية الهائلة

وبطريقة نموذجية الى ارتباط لصيق بين الباحثين والمزارعين على مدى سنين عديدة . وهذا يغاير كثيراً تجارب المحاصيل الموسمية . لهذا السبب فان مسألة التعويض في التجارب الحقلية للثروة الحيوانية أكثر أهمية من تلك في التجارب الحقلية للمحاصيل .

ان كثيراً من التجارب الحقلية للثروة الحيوانية الحالية يرجع أصلها الى مشاريع خاصة يتم تمويلها بواسطة وكالات غير قومية . ويتمثل أحد الأهداف الرئيسية لهذه التجارب في اتاحة الفرصة للباحثين القوميين ليكتسبوا خبرة في البحوث الحقلية . وقد أثبتت هذه الاستراتيجية نجاحها وانجزت عملاً تدريبياً هاماً للباحثين القوميين المعنيين . علاوة على ذلك ونسبة لأن مثل هذه التجارب قد أنشئت لأغراض محددة لحد ما وتم فصلها من الاتجاه السائد لأبحاث وكالات البحوث القومية فان مشاركة العاملين في الارشاد كانت عادة أقل من الدرجة المثالية . ويعتمد نجاح التجارب الحقلية للثروة الحيوانية في المستقبل وبدرجة هامة على انشاء علاقة عمل وطيدة بين فريق التجربة الحقلية للثروة الحيوانية والعاملين في الارشاد اذا ما أريد للتقنيات المختبرة أن تكون في متناول يد المجتمع الزراعي المستهدف . ونسبة لأن التجارب الحقلية للثروة الحيوانية لم تصل بعد لدرجة العمل الروتيني فان العلاقات بين فرق التجارب الحقلية للثروة الحيوانية ووكالات الارشاد هي في الواقع علاقات غير رسمية . وعلى مجموعات بحث التجارب الحقلية للثروة الحيوانية أخذ زمام المبادرة وقيادة المشاركة المنتظمة واللصيقة بعمل العاملين في الارشاد على أن تبدأ في مرحلة مبكرة من البحث متى كان ذلك عملياً .

ورغماً عن أنه تمت الاشارة إلى بدايات التدريب على طرق اجراء التجارب الحقلية للثروة الحيوانية الا أنه من المهم القاء بعض الضوء على حاجة الكثير من الباحثين للتعرض لكيفية التنفيذ إذ يجب على كل من الأعضاء الجدد في مؤسسة البحث والباحثين ذوي الخبرة أن يشاركوا في التجارب الحقلية للثروة الحيوانية . واشتراك المجموعتين المبكر سيكون له تأثيرات ايجابية على المواقف تجاه التجارب الحقلية . اضافة الى ذلك يجب على الخبرة الحقلية أن تساند ازدياد تلاؤم بحوث الثروة الحيوانية التي يتم تأسيسها في المحطات . وبالرغم من أن التجارب الحقلية للثروة الحيوانية ستكتسب أهمية في السنوات القادمة الا أن الحاجة لامكانيات المحطات المتوفرة لبحوث الثروة الحيوانية ستظل باقية . أن تقوية الصلات بين تجارب الثروة الحيوانية في محطات البحوث وفي الحقل سيزيد من فعالية العملية البحثية ككل .

ان مدى التجارب الحقلية التي تم تنفيذها فعلياً على الثروة الحيوانية تشير الى أنه يمكن للحقول أن تكون المواقع المناسبة لاجراء تجارب مفيدة للثروة الحيوانية فيما

يمثل تعويض المزارعين عن اشتراكهم في التجارب الحقلية للثروة الحيوانية مسألة أخرى تجد الاهتمام حاليا. فقد نوه كتاب كثيرون الى الحاجة لتقليل أو حتى ازالة المخاطر التي تصاحب الاشتراك والتي تنشأ من خلال فشل التقنية تحت الاختبار. والامثلة على مثل هذه المخاطر تشمل نفوق الحيوانات أثناء التجارب وفقدان فرص الانتاج عند استعمال أراضي المحاصيل كمراعي وانخفاض انتاجية الحليب عند تغذية المواشي بالعلائق الفقيرة... الخ وبالرغم من أن لمخاطر الانتاج اعتبار هام — من دون أي شك — في تصميم وعمل التقنية الحديثة الا أنه يجب ألا ينسى أن المزارعين يديرون مواردهم ويتخذون القرارات في بيئة غير مضمونة أحيائياً وفنياً واقتصادياً فالانتاج الزارعي — بما في ذلك الانتاج الحيواني — معرض للمخاطر. لهذا السبب لا يكون مناسباً تعويض المزارعين (بخلطة من عدة طرق في العادة) لمشاركتهم في التجارب الحقلية الخاصة بتقنيات الثروة الحيوانية الى الدرجة التي تلغي وجود المخاطرة في التجربة. ان ازالة كل المخاطر الناتجة من الاشتراك تجعل نتائج التجارب الحقلية للثروة الحيوانية غير قابلة للتفسير بدرجة كبيرة فيما يتعلق بقابلية التقنية للتطبيق عند المزارعين الآخرين الذين أريد نقلها نهائياً لهم. وقد يأخذ التعويض عدة أشكال، فمثلاً يمكن أن تسهل المشاركة في التجربة الحقلية للثروة الحيوانية عملية التحصل على مدخلات الحقل الضرورية (بما في ذلك المدخلات الأخرى التي لا تحتاجها التجربة الحقلية) كما يمكنها توفير حماية اضافية لحيازة الأرض. عليه فان اتفاقية التعويض عن المشاركة في التجارب الحقلية غالباً ما تكون أكثر سخاء مما يبينه الجمع البسيط للمدخلات الطبيعية المباشرة والنصيحة التي تسديها مجموعة البحث. وكحكم عام يمكن القول بأن الاتفاقية العامة للتعويض عن المشاركة وبمنأى عن الحالات الخاصة يجب أن لا تتعدى ما يمكن تقديمه للمزارعين عند نقل التقنية لمجتمع المزارعين الكبير بواسطة الخدمات الارشادية بعد انتهاء مرحلة الاختبار.

وبتبني هذا الحكم فإن بيئة التجارب الحقلية للثروة الحيوانية ستماثل البيئة السياسية العامة التي ينتج فيها المزارعون. وفي بعض الأحيان وخاصة بالنسبة لتلك التقنيات التي يتوقع أن يأخذ اختبارها الحقلي فترة طويلة نسبياً يكون من الأنسب عرض اتفاقيات للتعويض تنسجم مع البيئة السياسية التي يتوقع أن تكون سائدة في الوقت الذي تكون فيه التقنية جاهزة للتبني العام. ان مسألة التعويض معقدة لكن وفي كل الحالات يجب على الباحثين المهتمين بالتجارب الحقلية للثروة الحيوانية أن يتجنبوا البحث عن نجاحات مبكرة لتجاربهم بعرضهم اتفاقيات تعويض مفضلة يمكن أن تكون على حساب فشل لاحق في تبني أغلبية المزارعين الذين لا يتحصلون على نفس هذه الفوائد. أيضاً يجب ملاحظة أن التجارب الحقلية للثروة الحيوانية تحتاج

لم تنافس البحوث التقليدية للثروة الحيوانية على الاعتمادات المالية المركزية المتوفرة لهيئات البحوث القومية. ولقد كان للتمويل بواسطة الوكالات غير القومية هذه دور العامل المساعد في عملية التركيز على ملاءمة اشتراك المزارع بدرجة أكبر في تصميم وتجربة تقنيات حديثة للثروة الحيوانية. غير أن هذا النوع من التمويل لا يمكنه — كما يجب أن لا يحاول — أن يكون بديلاً في المدى البعيد عن بحوث الوكالات القومية في معالجة المشاكل البحثية التي ستصبح مقصورة على مواقع معينة. وبما أن التجارب الحقلية للثروة الحيوانية ستكون وسيلة هامة لاعداد التقنيات الملائمة للمواشي على نحو متزايد فانها ستحتاج لأن تقبل كبحوث «شرعية» بواسطة مؤسسات البحوث القومية.

ويلقي هذا التلخيص ضوءاً على بعض المسائل الرئيسية التي تتعلق بتطبيق التجارب الحقلية للثروة الحيوانية في المستقبل. وتتيح المعالجة الناجحة لهذه المسائل الفرصة لهذه التجارب لتكون جزءاً مقبولاً وروتينياً من بحوث الثروة الحيوانية في الوكالات القومية.

ان أحد الموضوعات التي تلقى الاهتمام حالياً من قبل كل من المراقبين والممارسين للتجارب الحقلية للثروة الحيوانية هو أن تكلفة البحث الذي يستعمل النهج الحقلي يجب أن تكون أقل من تكلفة نفس العمل اذا تم انجازه بالطريقة التقليدية أو في محطات البحوث. وهذا التركيز على التكاليف قد صرف النظر عن المقياس الأكثر أهمية لمقارنة الاتجاهين والذي يتمثل في مقارنة الآثار المنعكسة على الانتاج (الفوائد) مع تكاليف البحث. ورغماً عن وجود مشاكل أساسية في مواجهة طرق تقييم تأثير البحث (الذي ينبع من تجارب المحطات أو التجارب الحقلية) فانه من المهم في هذه المرحلة من تطور التجارب الحقلية للثروة الحيوانية أن تجري محاولة التقييم ليتم تأسيس هذه التجارب على قواعد متينة.

لقد عمدت قلة من التجارب الحقلية للثروة الحيوانية الى تقدير الفوائد التي تعود على المزارعين غير المشاركين في التجارب. وطالما أن المنتفعين من التغيرات الفنية في انتاج الثروة الحيوانية يشملون المستهلكين الحضريين وغيرهم، من خلال تغييرات رئيسية في أسعار السوق والكميات المعروضة، فسوف يكون تقدير مثل هذه التأثيرات كجزء من التقييم الكلي للتقنية الحديثة مناسباً في أغلب الأحيان. ويلاحظ هنا وجود ميزة رئيسية للتقنيات التي تختبر في الحقل (في مقابل التي تختبر في المحطة) والتي يمكن أن تكون تبنياً مبكراً بواسطة مجموعات كبيرة من المزارعين. واذا أخذنا الحاجة الملحة لايجاد تغييرات في كثير من نظم الانتاج فان هذه الميزة المتوقعة للاتجاه الحقلي تتخذ أهمية كبيرة. عليه فان تقييم التأثير يصبح مهمة ذات أولوية.

اتجاهات التجارب المستقبلية

فرانك م. أندرسون

مركز المواشي الدولي لافريقيا (إلكا)، ص ب (٥٦٨٩)، أديس أبابا، أثيوبيا

يجب التحصل على زيادة سريعة في الانتاج في كثير من مناطق العالم الزراعية لكي يتم توفير الاحتياجات — حتى الضرورية لا ستمرار البقاء — في العقود المقبلة. ويمثل امتلاك المواشي مكوناً عاماً في أغلب النظم الزراعية التي تعمل من أجل العيش فقط وذات الدخل المنخفض. وتشير الدلائل المتوفرة من عدة حالات الى أن الزيادة الملحوظة في الانتاج ممكنة ومربحة في مشاريع الثروة الحيوانية هذه خاصة اذا تم توجيه الحزم الفنية الضرورية نحو احتياجات وموارد المزارعين. وباستثمار هذه الفرص لزيادة انتاجية كل من منتجات المواشي الوسطى كالقوة الساحبة والمنتجات النهائية كاللحم والحليب سيصبح المزارعون أكثر مقدرة لتلبية احتياجاتهم الأساسية. ان اجراء التجارب الحقلية للثروة الحيوانية يمثل طريقة فعالة لتصميم واختبار تقنيات المواشي الملائمة لكي يتبناها المزارعون لتحقيق الهدف العام للانتاج.

تعتبر التجارب الحقلية للثروة الحيوانية في بداية الطريق مقارنة بتجارب المحاصيل. ورغماً عن القلة النسبية للحالات الدراسية المتوفرة الا أن النتائج التي تم التحصل عليها حتى هذه اللحظة تفيد بأن التجارب الحقلية للثروة الحيوانية قادرة على استخلاص نتائج تتناسب واحتياجات المزارعين. ونسبة لما تتمتع به هذه التجارب من فعالية في استعمال الاعتمادات المالية الشحيحة للبحوث في اعداد التقنيات الخاصة بالثروة الحيوانية فانها ستنافس بنجاح على جزء من هذه الاعتمادات على أقل تقدير. وعلى كل حال فان الكثير من الأبحاث الخاصة بالتجارب الحقلية للثروة الحيوانية يتم تمويلها حالياً بواسطة الوكالات الثنائية أو المتعددة التكوين وهيئات البحوث الدولية. نتيجة لذلك فان التجارب التي تم تنفيذها بدعم من هذه الوكالات

وكلما يزداد فهم نظم انتاج المواشي ويصبح الباحثون أكثر ثقة في التقنيات تحت ظروف المزارعين يكون من المحتمل أن تتجه التجارب الحقلية للثروة الحيوانية الى أسلوب اداري بزيادة في درجة مشاركة المزارعين وزيادة في التركيز على الأسس الاجتماعية الثقافية كتسب التبني .

ان أكثر تجاربنا الحقلية للثروة الحيوانية في الحلقة الدراسية هذه قد أوضحت بجلاء أننا في أول مرحلة تطور منهجية التجارب الحقلية ويتمثل التحدي في كيفية تحركنا كعلماء مواشي من التركيز على الباحث والتقنية الى التركيز على المزارع والتبني .

الانسجام الاجتماعي الثقافي

ان أوضح تعبير عن الانسجام الاجتماعي الثقافي لتقنية جديدة في نظام زراعي هو تبنيها التام بواسطة المزارع الذي يقدم كل المدخلات المطلوبة من موارده الخاصة. وقياس نسب التبني يمثل طريقة واحدة لأخذ قياسات كمية لانسجام النظام مع التقنية. فضلاً عن ذلك فان الانحرافات عن الاساليب المقترحة — كما توضحها مناشط الرصد الحقلية — توفر معلومات هامة يستعملها الباحثون لتكييف وتعديل التقنيات لتتلاءم بصورة أفضل مع النظام المستهدف.

يجب ألا ينتظر تقييم الانسجام الاجتماعي الثقافي حتى انتهاء اختبار التقنية. ويمكن لمشاركة المزارع وتقييمه — حتى لو كان ذلك في مراحل تصميم التقنية — مساعدة الباحثين في تصميم تقنيات ملائمة للمجموعات المستهدفة. ولأن واحداً من الأهداف الرئيسية للتجارب الحقلية للثروة الحيوانية هو تسهيل نقل التقنية للمزارع في أقل فترة زمنية ممكنة فان اشتراك المزارعين والعاملين في الارشاد في وقت مبكر يصبح أمراً حتمياً. ورغماً عن أن تقييم المزارع يمثل عنصراً أساسياً في تقييم الانسجام الاجتماعي الثقافي للتقنية الا أنه يمكن أن يكون لأصحاب القرار السياسي على الصعيدين الاقليمي والقومي تأثير هام على تقبلها. عليه يجب تقييم نتائج التجارب الحقلية للثروة الحيوانية في اطار أولويات التنمية الاقليمية والقومية. والتبني الناجح للتقنية التي تتفق مع هذه الأهداف يلقى فرصاً أكبر للدعم مما يعزز امكانية تنفيذ السياسات التي تساعد المزارعين في تبني التقنية المقترحة.

خاتمة

تمثل الأسس الرئيسية الثلاث (الفعالية الفنية والفوائد الاقتصادية والانسجام الاجتماعي الثقافي) مجالات عريضة يجب الرجوع اليها عند تقييم نتائج التجارب الحقلية غير أنه لا يمكن تصميم كل تجربة حقلية للثروة الحيوانية لتتعرض لكل هذه الأسس في آن واحد. لقد ركزت المجهودات المبكرة في تطور الطرق البحثية المستعملة في التجارب الحقلية للثروة الحيوانية على تعريف التقنية تحت ظروف المزارعين. وقد كانت هذه التجارب تحت اشراف الباحثين بصورة ثابتة وركزت على تقييم فعالية التقنية الواعدة. ومن المحتمل أن يجعل اشتراك المزارع بدرجة أكبر في مرحلة التجارب الحقلية هذه تنقية التقنية أكثر فعالية وأكثر ملاءمة لأحوال المزارعين.

يستعمل لتقييم هذا التأثير يحاول عادة تأسيس فوائد اقتصادية قابلة للقياس يمكن أن تعود للمنتج من خلال تبنّيه للتقنية المقترحة . ويجب أن تنسجم هذه التقنيات مع قاعدة الموارد الاقتصادية للمزارع وأن تستعمل هذه الموارد بطريقة أكثر فعالية لتوسيع فرصها في التبني .

يتطلب تقدير الفوائد الاقتصادية للمنتجين تقييم واقعي لمواردهم الاقتصادية (الأرض والعمالة ورأس المال) ومعرفة الطريقة التقليدية التي يتم بها توزيع هذه الموارد على مشاريع الانتاج الخاصة بالمنتج . ان فهم أولويات الانتاج لدى المنتج يمثل عاملاً هاماً لتمكين الباحث من اختيار معايير الانتاج الملائمة (مبيعات الحيوان ، مبيعات الحليب ، والذبيح للاستهلاك المنزلي) للقيام بالتحليل الاقتصادي المناسب . وفي حالة المزارعين ذوي الموارد البسيطة فان النقص الموسمي في النقد والعمالة كالذي يحدث خلال فترتي الزراعة والحصاد يمكن أن يكون له تأثيرات هامة على نجاح الابتكار الواعد . ان تفهم التقلبات الموسمية في اسعار السوق له أبعاد هامة عند حساب تكلفة انتاج المواشي اذ أن المواشي تباع عادة خلال الفترات التي تحتاج فيها الأسر الى دخل في متناول اليد . وفي حالة المجترات الكبيرة يمكن أن تكون هذه المبيعات شاذة ومعتمدة على الحاجة وتم اتخاذها دون اعتبار لاتجاهات أسعار السوق . إن تقييم تكاليف المدخلات يحتاج أيضاً الى اعتبارات لا تقتصر على تواجدها الموسمي فحسب ولكن تشمل أيضاً التكلفة البديلة . ويمكن أن تكون هذه المدخلات عالية التكلفة في المناطق التي تفتقر الى البنية التحتية مما يتطلب قدراً كبيراً من التخطيط لتوفير المستلزمات ومجهوداً كبيراً من المنتجين .

ويجب أن يحاول التحليل الاقتصادي تقدير أسعار حقل حقيقية لكل من المدخلات والمنتجات . وتمثل المعايير كالمربحية وصافي الفائدة الحدية ونسبة الفائدة الى التكلفة ... الخ مؤشرات واقعية للباحثين ليقيموا الفوائد الاقتصادية المتوقعة ولكن بشرط أن تكون هنالك مجهودات بذلت لتقييم التفاعلات الحقيقية بين المزارع والسوق .

هنالك اختلاف هام بين انتاج المواشي وانتاج المحاصيل يتمثل في صعوبة أخذ مقاييس كمية لكثير من منتجات المواشي وبالتالي صعوبة اضفاء قيماً مادية على هذه المنتجات . وفي هذه الحالات يجب أن يشمل تقدير التأثير الاقتصادي للتقنية على النظام الزراعي كل من التحليل الاقتصادي واستجابة المزارعين الرسمية وغير الرسمية .

السمات الطبيعية والحيوية لقاعدة الموارد الطبيعية، (ج) توزيع المدخلات، (د) حدوث المرض و (هـ) الامكانيات الانتاجية للمواشي. بناء على ذلك فان تقييم الفعالية الفنية للابتكار المقترح يجب ألا يقتصر على اعتبار تغيرات الانتاج (انتاجية الحيوان) فحسب بل يجب أن يشمل أيضاً تأثيرات التقنية على قاعدة موارد المدخلات.

وبالنسبة للمواشي فان تغيرات الانتاج غالباً ما تعتبر متساوية مع تغير في الانتاجية (زيادة الوزن، الفترة الزمنية بين الولادات، انتاج الحليب، ... الخ). ان احتمالات مقارنة التغيرات القابلة للقياس في واحد أو أكثر من أسس الانتاجية مع تغير الانتاج الكلي للنظام تحددها طبيعة النظام (محصول — مواشي، رعوي، تجاري)، وأولويات الانتاج لدى المنتج.

ان الاعتماد على المقاييس الكمية والكيفية لتعكس بصورة واقعية التأثير على الانتاج من النظام المستهدف يتحدد بواسطة: (أ) اختيار وقياس الأسس التي تعكس أولويات الانتاج عند المنتج، (ب) مساهمة المواشي كمياً وكيفياً في جملة انتاج النظام، (ج) التحيزات الناتجة عن توفير مدخلات الانتاج بواسطة الباحثين و (د) دقة المقاييس وأنواع الطرق التحليلية المستعملة. اضافة الى ذلك يجب اعطاء اعتبار للطبيعة الفنية للمدخلات ومستواها المطلوب ومدى توفرها للمنتج على أساس دائم أو موسمي.

ان النجاح طويل الأمد للتقنيات التي تم تبنيها حديثاً سيعتمد جزئياً على تأثير هذه الابتكارات على قاعدة الموارد الطبيعية في النظم المستهدفة. وهنالك أهمية خاصة في حالة النظم الرعوية — لكنها تنطبق على كل النظم الزراعية — للتقنيات التي تكون موجهة لتحسين مقدرة المنتج لاستعمال موارده الطبيعية بصورة أكثر فعالية وبطريقة تضمن صيانتها وحفظها. ان مثل هذه التقنيات لها أهمية كبيرة عند محاولة تركيز وتحسين الموارد البيئية المتدهورة. وانسجام التقنيات الواعدة مع التحسين طويل الأمد لقاعدة الموارد الطبيعية يمثل عاملاً هاماً يجب أخذه في الاعتبار عند تقييم الفعالية الفنية للتقنيات التي تخضع للتقييم عن طريق التجارب الحقلية للثروة الحيوانية.

الفوائد الاقتصادية

يمثل تأثير التقنية على قاعدة الموارد الاقتصادية عند المزارع المستهدف عاملاً هاماً في تقييم نتائج التجربة الحقلية للثروة الحيوانية. ان التحليل الاقتصادي الذي

أسس التقييم

ريتشارد كوك

مشروع تطوير البحوث الزراعية لغرب السودان، هيئة البحوث الزراعية،
ص ب (٥١٤١)، الخرطوم جنوب السودان

تتمثل الأهداف الرئيسية للتجارب الحقلية للثروة الحيوانية في اختبار ملاءمة التقنيات التي تزيد الانتاج أو تخفض التكلفة وفي تسهيل عملية نقل هذه التقنيات الى أكبر عدد ممكن من المزارعين المستهدفين. عليه يجب أن توفر نتائج هذه التجارب فهماً تاماً للباحثين عن الفعالية الفنية والفوائد الاقتصادية والانسجام الاجتماعي الثقافي للتقنيات الواعدة وذلك في محيط النظام الزراعي المستهدف. واستناداً على طبيعة التقنية قيد الاختبار فان تعقيداتها الفنية وكمية التنقية الأولية ومتطلباتها من المدخلات ومواصفات مشاريع الانتاج في النظام المستهدف قد تتطلب وقتاً طويلاً قبل أن تتضح هذه الأسس بصورة كافية تمكن من التوصية بنشر التقنية. واعتماداً على هذه الحقيقة ونسبة للمستوى العالي للموارد التي يتكرر طلبها لتنفيذ التجارب الحقلية للثروة الحيوانية فانه يجب تنقية التقنيات الواعدة بصورة حاسمة وأن يتم تقييم تصميمات التجارب الحقلية والنتائج بصورة حاسمة أيضاً لأجل توسيع امكانيات نشر الابتكارات القابلة للتبني في أوساط المنتجين في أقل فترة زمنية.

الفعالية الفنية

تتطلب الفعالية الفنية لأي ابتكار مقترح تقييم كمي وكيفي لكل من استجابة الحيوان الحيوية للتقنية والانسجام الفني للابتكار مع قاعدة الموارد في النظام الزراعي. وفي حالة النظم الزراعية الخاصة بالمواشي نجد أن كثيراً من معوقات الانتاج التي تواجه المنتجين التقليديين مؤسسة على أسباب فنية. ان مستويات انتاجية المواشي في نظم الانتاج التقليدية تعكس النتيجة الحتمية لعدة تفاعلات فنية تشترك فيها عدة عوامل منها: (أ) عمليات الادارة والعناية، (ب)

لقد أضحت الحاجة لعقد اتفاقيات ــ رسمية كانت أم غير رسمية ــ مع المزارع معروفة تماماً ولم يعلن عن وجود سوء تفاهم بدرجة خطيرة الا أن من المهم تنبيه العلماء الى ضرورة أخذ رغبات المزارعين بعين الاعتبار عند صياغة الاتفاقيات معهم.

ولقد لوحظ ان المناشط الحالية للتجارب الحقلية للثروة الحيوانية تشرك المزارعين في المسح التشخيصي وتنفيذ وتقييم التجارب الا أن اشتراك المزارعين كان محدوداً خلال مرحلة تصميم التجارب ومرحلة التقييم المستمر. وعليه فان هذه المجالات تحتاج الى عناية أكثر في المستقبل.

مراجعة مشاركة المزارع

لقد كانت هنالك اختلافات كبيرة بين الأوراق التي قدمت في الحلقة الدراسية بالنسبة لمشاركة المزارع. فهنالك الحالات التي وصل فيها اختبار التقنية مرحلة التعميم وتم تزويد المزارع بالارشاد الفني والتوجيه وتركت لهم حرية اتخاذ القرارات الخاصة بتصميم التجارب وادارتها وكيفية الاستفادة من منتجاتها. وفي اثناء هذه العملية يكون المزارعون قادرون على تعديل الحزمة التقنية. وبالفعل فان الباحثين يتعلمون من التجارب التي يجريها المزارعون. كمثال على ذلك فان بعض المزارعين المتعاونين مع مشروع ادخال زراعة الأشجار الرعوية في الحقول جنباً الى المحاصيل الأخرى في نيجيريا قد حرقوا مخلفات الحصاد المتجمعة بين صفوف الأشجار. هذا ولم توضح أغلب الأوراق ان كان المزارعون قد شاركوا في تصميم التجارب الحقلية أم لا إلا أنه بدى واضحاً أن ممارسات المزارعين التقليدية قد أخذت في الاعتبار عند تصميم التجارب لأن الطريقة التقليدية مثلت مجموعة الشاهد. وهنالك حالات عديدة أخذت فيها طموحات المزارعين بعين الاعتبار خلال تنفيذ التجارب الحقلية للثروة الحيوانية وكانت النتائج ايجابية في العادة.

ان مساهمة المزارعين في مدخلات التجارب كانت متباينة ومتنوعة بدون أي استثناء حيث أنهم سمحوا باستعمال أراضيهم ومساكنهم وحيواناتهم وإمكانياتهم الأخرى (كالماء والتغذية). وفي الدراسة الخاصة بغرب السودان نجد أن البقارة لم يسمحوا باستخدام أبقارهم لجمع البيانات (نسبة لعدم وجود الثقة المتبادلة). وفي حالة واحدة اضطر الباحثون لدفع أجرة عن استعمال الحظائر الليلية في غرب كينيا. ولقد تم توفير حيوانات التجارب بواسطة فريق البحث في الحالات التي تمثل فيها نوعية حيوانات القطيع جزءاً من المبتكرات التقنية التي ستخضع للأختبار. وبصورة عامة فان العلماء قد حاولوا اشراك المزارعين في ادارة التجارب وذلك تحت اشراف فريق البحث. ولقد وجدت حالات قليلة تم فيها تدريب المزارعين لتسجيل المعلومات وتبقى الحاجة ماسة لمزيد من مشاركة المزارعين في مثل هذه العمليات.

وقد كان للمزارعين كل حرية في استعمال المنتجات الشيء الذي كان مشجعاً لهم فقد أخذت وجهات نظرهم وآرائهم عن نتائج التجارب في الحسبان وبطريقة ثابتة ولكنها كانت — وبصورة عامة — غير واضحة نسبة لما للحوافز والتعويضات من تأثير على آراء المزارعين. ان تقسيم المدخلات التي يوفرها فريق البحث الى عدة مراحل يساعد في أخذ وجهات نظر المزارعين وردود فعلهم بالنسبة للتقنيات قيد الاختبار بصورة أكثر دقة.

وتختلف أهمية أي من هذه القيم باختلاف المجتمعات أو المجموعات الاجتماعية. وعلى وجه العموم يمكن للشخص القول بأن أصحاب المواشي في المناطق الجافة أكثر اعتماداً على المواشي أو أكثر التصاقاً بها وأنهم غير متحمسين للدخول في اتفاقيات تقضي باستخدام حيواناتهم في التجارب الحقلية للثروة الحيوانية.

عموماً فانه يحبذ أخذ رغبات المزارعين في الأعتبار وأن يتمكن أصحاب المواشي من التخلص بقدر من استطاع من القطعان أو منتجاتها إما للاستهلاك المنزلي أو لتأمين دخل نقدي. ففي مزارع الألبان مثلاً يجب أن يطمئن المزارع الى حقه في الحلب كما يجب أن تكون العينات صغيرة. وفي حالة وجود قطعان كبيرة عند المزارعين يجب استبعاد القطعان التي يحتمل التخلص منها في وقت قصير واستناداً على ذلك فان الاتفاقيات قصيرة الأجل قد تكون مرغوبة أكثر.

وبما أن أصحاب المواشي يتحصلون على المنتجات الاستهلاكية والدخل من قطعانهم يجب أن تهدف التجارب الحقلية للثروة الحيوانية الى زيادة انتاجية هذه الحيوانات. ان أهمية تصميم تجارب تستعمل فيها أساليب الادارة التقليدية كشاهد قد تم تأكيده من قبل. وأي اتفاقية عادلة يجب أن تضمن أداء جيداً لمجموعات المعاملة بحيث لا يكون أقل من مستوى مجموعة الشاهد على أن توفر التعويضات المناسبة في الحالات التي تكون فيها مجموعات المعاملة ضعيفة الاداء نسبياً. كذلك يحبذ دفع القيمة المادية في مقابل الاصابات التي تنتج عن معاملة الحيوانات أو النفوق في مجموعات المعاملة على أن يتم الدفع بغض النظر عن المسسببات. وعند توفر خدمات التأمين فانه يجب التأمين على القطيع بأكمله.

أيضاً يجب أن تحمي الاتفاقية المزارعين من المخاطر الناتجة عن الاستثمار طويل الأمد في البنود الرئيسية (الحظائر، السياج، حفظ التربة). ويجب أن تكون الاتفاقيات مرنة بحيث يستطيع المزارع اجراء التغييرات الضرورية بل والغاء الاتفاقية بأكملها ان أراد ذلك.

ان شكل الاتفاقية يعتمد على الموقع. ففي بعض الأقطار تكون الاتفاقيات الشفهية مقبولة وجديرة بالاحترام وفي بعض الأقطار الأخرى يمكن الاستعانة بشهادة القادة في القرى عند اجراء الاتفاقيات غير الرسمية. وفي الطرف الآخر تمثل الاتفاقية الرسمية التي تصاغ بواسطة محامي النوع الأوحد من الاتفاقيات التي تلقى القبول.

ولكيما يتمكن المزارعون من الاشتراك بطريقة مفيدة في التجارب الحقلية للثروة الحيوانية يجب أن يتم تدريب وتوجيه المزارع على مسار البحث الا أن هذه العملية قد تكون بطيئة وتتطلب الصبر. ان بعض الأعباء المحددة كتقسيم الحيوانات الى مجموعات تجريبية واختيار العينات قد تتطلب تدخل الباحثين المباشر والمستمر كما ان أخذ قياسات المدخلات والقياسات الفنية يجب أن تكون مبسطة لاستعمال المزارعين. فمثلاً يمكن استعمال المكاييل لقياس الأعلاف المركزة وانتاجية الحليب. أيضاً يمكن تبسيط وتعديل استمارات تسجيل المعلومات (صفحات التسجيل الاسبوعي أو اليومي) لكي تملأ بواسطة المزارعين اذ أن الاستمارات المعقدة غير مناسبة لاستعمالهم.

ان اختيار المزارعين لادارة تجربة حقلية للثروة الحيوانية يتطلب زمناً غير قليل الشيء الذي يصرفهم عن ممارسة أعمالهم الروتينية مما قد يتطلب إيجاد عمالة بديلة. لذا يجب أن تبحث هذه المسألة بعناية تامة.

التقييم: ان المزارعين الذين يديرون التجارب الحقلية للثروة الحيوانية يقيمون باستمرار آثار المعاملات نسبة لأنهم يلحظون التغيرات التي تطرأ على أحوال حيواناتهم أو على مستوى أدائها ويجب على الباحثين أن يشجعوا المزارعين لابداء آرائهم عن المعاملات. أيضاً يجب تدعيم تقييم المزارعيين ان كان صحيحاً كما تجب مراجعة التفسير الخاطىء ولكن في حرص تام. وينبغي أن يزود المزارعون بنسخ من التلخيصات المبسطة عن بيانات التجربة الحقلية. وعندما تصل الدراسات الى مرحلة متقدمة ومؤكدة يمكن للباحثين أن يستخدموا المزارعين في نشر التقنيات المناسبة. ويجب أن تستكشف امكانية اقامة أيام حقلية تضم المزارعين المتعاونين اذ أنها تعجل بعملية تبادل الخبرات. كذلك يمكن اقامة التقييمات الرسمية على فترات. ان تقييم التجارب الحقلية للثروة الحيوانية يجب أن يكون شاملاً وأن يحوي آراء المجموعات الأخرى كالعاملين في الارشاد وأصحاب القرار السياسي.

أسس الاتفاق: من الضروري تمييز الدور الخاص للمواشي في المزارع الصغيرة عند مناقشة الاتفاقيات الخاصة باستخدام الحيوانات في التجارب الحقلية مع المزارعين اذ أن المواشي تعني استثماراً بالنسبة للمزارعين (حساب في البنك أو سندات أو رأس مال) وغذاء للأسرة (ماعز وأغنام) وتأمين ضد فشل المحاصيل (تمثل المواشي بالمناطق الجافة استمراراً للحياة في مواسم الجفاف) وتأمين ضد الشيخوخة (يعتمد المسنون على المواشي أكثر من اعتمادهم على زراعة الأرض) ووحدات تأهيل لرتب وقيم اجتماعية عالية (مهر للعروسة أو وظائف اجتماعية).

مرحلة التصميم: يجب أن يناقش فريق البحث مع المزارعين أثناء مرحلة التصميم الفائدة التي تكمن في التجارب الحقلية للثروة الحيوانية لايجاد الحلول لمشاكلهم. أيضاً يجب أن توضح المشاكل والمعوقات التي تصاحب هذه التجارب. ومن الناحية الأخرى، يجب منح الفرصة للمزارعين ليعبروا عن طموحاتهم التي ربما أمكن تضمين بعض منها في تصميم التجارب. ومثال على ذلك أنه عند وجود شعور قوي لدى المزارعين بأن واحدة من طرق زيادة انتاج الحليب تتمثل في ادخال سلالات محسنة بدلاً عن تحسين الغذاء فانه يمكن تضمين هذا الرأي في التصميم رغماً من عدم وروده في الخطط الأصلية.

أيضاً يجب أن يناقش الباحثون أثناء هذه المرحلة أهداف التجارب الحقلية للثروة الحيوانية والخطط بكامل تفاصيلها مع المزارعين وأن يتم تحديد مجموع الاحتياجات للتجارب والمساهمة التي يستطيع المزارعون تقديمها من امكانيات (حظائر ومياه شرب وأرض) ومدخلات (أعلاف وأدوية بيطرية وعمالة). ومن المهم جداً تجنب الافراط في طلب موارد المزارعين وكذلك يجب على العلماء أن يتجنبوا الافراط في الالتزام وأن لا يستخدموا المدخلات الخارجية الفخمة التي لا يتسنى للمزارعين اقتنائها بعد انتهاء التجارب. ويجب أن تستخدم البيانات الخاصة بدخل الأسرة وإنفاقها في التخطيط لتحديد مستوى مدخلات الحقل الخارجية. كذلك فانه يجب مناقشة المسائل المتعلقة بالحماية ضد المخاطرة والتعويضات والحوافز للمزارعين على أن تتم مناقشة أشكال الاتفاقية في هذه المرحلة.

أما بالنسبة للجدول الزمني لنشاطات التجارب الحقلية للثروة الحيوانية فتحتم مناقشته بالتفصيل مع المزارعين حيث أن هذا يتيح لهم فرصة لتحديد المجالات التي يمكنهم المشاركة فيها من دون أن يتأثر روتين نشاطاتهم الانتاجية وكذلك المجالات التي سيحتاجون فيها الى مساعدة. فمثلاً اذا ما تداخل موعد زراعة المراعي المحسنة مع موعد زراعة المحاصيل الغذائية فمن الجائز أن يحتاج المزارع الى مساعدة. ويمكن بحث التفاصيل بدقة بحيث تتأكد مشاركة المزارع من غير أن تكون على حساب أعماله الروتينية الأخرى. كما يجب أن يقتنع الباحث بأن المزارعين يمثلون جزءاً من فريق البحث ويجب أن لا يستغلوا كعمال في هذه التجارب ولكن تجب معاملتهم كزملاء.

تنفيذ التجارب الحقلية للثروة الحيوانية: لقد تم التعرض لأهمية اشتراك المزارع في عملية النقل المتكامل للتقنية سابقاً. عليه يجب التقيد الى أقصى حد ممكن بالتصميم وجدول الأعمال الذي تم الاتفاق عليه مع المزارعين في مرحلة التصميم.

المناشط من اختصاص الباحثين المعنيين كما تقع على الباحث مسئولية تحديد الأشخاص الذين سيعاونونه .

ومن الناحية الأخرى فانه ليست للمزارعين دراية بعمليات البحث المطولة كما أنهم قد لا يدركون أهميتها ففي بعض الأوقات نجد المزارع ميالاً لاسقاط المعاملات التي ينتج عنها ضعف في أداء الحيوانات (مثال على ذلك : مجموعة من الحيوانات تعامل كشاهد ولاتحظى بأي علف اضافي في مقابل مجموعة أخرى تتم تغذيتها بأعلاف اضافية مما يزيد انتاجها من الحليب بدرجة ملحوظة) . وبما أن المزارعين يعرفون حيواناتهم واحداً واحداً فقد لا يحبون أن يروا بعضاً من حيواناتهم الجيدة تعامل معاملة أقل من المستوى أيضاً فان المزارعين قد لا يقدرون قيمة التجارب طويلة الأمد (كعمليات انتاج العجول من الأبقار في مقابل تسمين الثيران المخصية) .

عموماً يجب علينا أن نتوقع ضعف نسبي في الدقة اضافة الى مستويات إنتاج منخفضة في أعمال البحث التي يشارك فيها المزارعون غير أن هذه النتائج تعكس امكانيات استجابة الانتاجية للتقنية تحت الاختبار بصورة أكثر واقعية . ويجب أن تستعمل مثل هذه البيانات في التخطيط التنموي . أيضاً فان مشاركة المزارعين يمكن أن تعكس مدى تقبل المجتمع للتقنية المعنية . وبمرور الزمن فان كثير من العلماء الزراعيين يقبلون التحدي لدراسة امكانيات الانتاج في البيئات الاجتماعية والاقتصادية المختلفة . ولكيما تكلل هذه المجهودات بالنجاح من المهم جداً أن ينشىء العلماء علاقة عمل مع المزارعين في المراحل المختلفة من عملية اجراء التجارب الحقلية للثروة الحيوانية .

مشاركة المزارع في التجارب الحقلية

مرحلة المسح التشخيصي : لقد أصبح من الأساسي تطوير وتعزيز علاقة العمل بين الباحث والمزارع في مراحل مختلفة . ونظراً لأن أصحاب المواشي يتشككون في مقدرات الآخرين على ادارة المواشي يجب أن يحاول فريق البحث كسب ثقة المزارعين أثناء اجراء الدراسة الاستطلاعية . كما يجب أن تبرهن هيئة البحث عملياً على معرفتها بنوعية الأعمال التي تتعلق بالحيوانات وعلى مقدرتها للقيام بهذه الأعمال مثل معالجة الأمراض الشائعة والسقي والحلابة والادارة العامة . أيضاً فان من الأهمية بمكان مشاركتهم همومهم التي تتمثل عادة في المعوقات التي تواجههم أو مسبباتها . وعلى فريق البحث أيضاً أن يقدر مقدرات ومهارات المزارعين وأن يبدي اعجابه بها ويطريها اذا تطلب الأمر ذلك .

درجة مشاركة المزارع

ج. كاتيفيل

مركز البحوث للتنمية الدولية (آى دى آر سى)، نيروبي، كينيا

ان مجرد وجود تجربة حقلية للثروة الحيوانية يوحي ضمنياً بمشاركة المزارعين وذلك لعدة أسباب منطقية تشمل:

(أ) تستخدم التجارب الحقلية للثروة الحيوانية موارد المزارعين (كالمباني والارض والحيوانات والمدخلات الأخرى) ويصبح من الضروري تحديد المناشط بالحقل مع المزارعين المعنيين اذ أن هذا الاجراء يتيح الفرصة لاكتساب الثقة بالنفس.

(ب) بما أن التجارب الحقلية للثروة الحيوانية تهدف الى تعجيل نقل التقنية فان اتصال المزارع المباشر بالتقنية يسهل هذه العملية. وعند اشتراك المزارعين في هذه التجارب فانهم يستطيعون تقدير الأسباب التي دعت اليها ويمكنهم المعاونة في اقناع جيرانهم بفوائد التقنيات التي هي قيد الاختبار.

(ج) ان أصحاب المواشي عادة ما يمتنعون عن السماح للآخرين بالتحكم في حيواناتهم لادراكهم وجود بعض الاداريين الضعفاء ونسبة لوجود بعض المعتقدات الخرافية فانهم يقرنون ضعف أداء الحيوان بعشائر أو عائلات معينة. ولقد أوردت بعض الأمثلة في هذه الحلقة الدراسية عن أن بعض الرعاة لم يثقوا بالعلماء في بادىء الأمر.

(د) تدل مستويات الانتاج المتحصل عليها بمشاركة المزارع على إمكانيات التحسين بصورة أكثر واقعية من تلك المتحصل عليها في محطات البحوث.

إن العلماء في محطات البحوث أكثر معرفة بوثائق البحث المعدة على قواعد أساسية حيث تصدر التعليمات للفنيين بالتنفيذ، كذلك فان الهيئات المساعدة الأخرى (كمساعدي المخابر والعمال) تكون معتادة على العمليات البحثية كطرق أخذ العينات وتجهيزها. وبما أن الخط القيادي مفهوم ونافذ المفعول فان هذا يؤكد على جودة عالية للبحث. إن النظرة التقليدية لمناشط البحث المختلفة هي أن هذه

الاحياجات والتكلفة

ان تكاليف البحث الحقلي وثيقة الصلة بتصميم وموقع التجربة. وتكون التكاليف الأساسية في شكل مصروفات النقل ومتطلبات الباحثين والمزارعين من حيث الزمن والموارد. وتمثل عوامل التكلفة اعتبارات هامة عند اختيار مواقع الدراسة وأعداد المزارعين. ولتخفيض نفقات السفر فان مواقع البحث تكون عادة مجمعة في منطقة أو منطقتين محددتين.

من المرجح ان تكون التجارب الحقلية على الحيوانات اقل تكلفة للمؤسسة البحثية مقارنة بالتجارب في محطات البحوث إذ أن استعمال موارد المزارعين كالحيوانات والمواد الغذائية والارض والعمالة يقلل من تكلفة البحث. غير أن هذه الوفورات تتلاشى جزئياً عن طريق حجم العينة وتكاليف الحوافز والتعويضات والسفر.

ولتخفيض تكاليف التجارب الحقلية للثروة الحيوانية تكون الحاجة ملحة لتبسيط التصميم كتحديد عددية المعاملات والآثار ذات القياسات الجاهزة غير أن الكثير من هذه الوفورات يفقد نسبة للحاجة للمشاهدات المكثفة والتي غالباً ما تمتد لأكثر من عام. كذلك فان التقلبات الكبيرة والمتأصلة ــ وبالتالي حجم عينة أكبر ــ تحد من الفوائد التي يمكن الحصول عليها. ان ادخال أكثر من معاملة واحدة يمكن أن يؤدي الى زيادة فعالية التكلفة ولكن يجب أن تقاس هذه الفائدة في مقابل الخسارة في فعالية التجربة ويمكن أن تكون المعلومات التي تم تجميعها في المرحلة التشخيصية ذات أهمية في هذا الخصوص. وقد يكون عمل المسح الاستطلاعي واحد من أكثر السمات الفعالة لمناشط التجربة الحقلية. ان تخفيض اللقاءات المتكررة بين الباحث والمزارع يساهم في تقليل النفقات ولكنه يؤدي الى انخفاض جودة التجارب الحقلية للثروة الحيوانية في نفس الوقت.

والذي يعكس لحد ما اختلاف طرق معالجة المشاكل التي تتبعها مجموعات البحث المختلفة. عليه فانه لا يمكن تحديد توصية معينة نسبة لأن حجم العينة يعتمد بصورة قاطعة على المتغير الذي يراد قياسه.

ان التقلبات التي تصاحب المتغير الذي يراد دراسته ودرجة الثقة المرغوب فيها يحددان حجم العينة وذلك عند أخذ القياسات الكمية للمتغيرات الحيوية حيث يعتبر التحليل الاحصائي هاماً في أغلب الأحيان. غير أن حجم العينة الذي يحسب لأخذ القياسات منه قد يكون كبيراً وغير عملي. وبما أن الطرق الاحصائية ليست دائماً ضرورية أو ذات مغزى كبير بالنسبة للتجارب الحقلية للثروة الحيوانية فانه يمكن أخذ الملاحظات عن عامل معين وخاصة العوامل التي تتعلق بالممارسات الراسخة والمنتشرة من عينة صغيرة الحجم وبثقة كافية بل وقد تكفي ملاحظة بسيطة في الحالات المتطرفة. أيضاً، فان هنالك وضعاً مماثلاً يتعلق بالتجارب الحقلية للثروة الحيوانية التي وصلت مرحلة البيان العملي أو التبني اذ أن الحاجة الى التحليل الاحصائي ــ وبالتالي حجم العينة ــ تكون محدودة نسبة لازدياد التركيز على النظام الزراعي ككل.

ويمكن للتجارب الحقلية للثروة التي تستعمل قطعاناً صغيرة من الحيوانات أن تأخذ في الاعتبار تطبيق معاملة واحدة للحقل مما يؤدي الى انخفاض عدد المعاملات الى واحدة بكل موقع حيث أنه لايمكن تطبيق اكثر من معاملة بالموقع الواحد الا اذا لم يتم اخطار المزارعين أو وجد أنهم لا يستطيعون تمييز المعاملات أو آثارها في حينها. الا أن مثل هذا النوع من التجارب يبقى نادراً ومحصوراً على التجارب التي يشرف على ادارتها الباحثون أنفسهم بهدف تجميع قدر كبير من المعلومات يفوق الحاجة الفعلية لحل المشكلة التي تواجه المزارع.

ان تحديد المعاملات في التجارب الحقلية للثروة الحيوانية يتم عادة بواسطة الباحث وذلك استناداً على نتائج البحوث التي أجريت في محطات البحوث أو على المعلومات التي تم تجميعها أثناء مرحلة التشخيص. واذا لم يتم تحديد المعاملات بوضوح تام فان المزارعين سيقدمون على تفسيرها أو تعديلها وفقاً لمتطلباتهم. ان تطبيق المعاملات بواسطة المزارعين يمكن أن يبعد التجربة عن هدفها الأساسي غير أنه يمكن أن يساهم في توفير معلومات قيمة ويعطي مؤشرات عن الكيفية التي يمكن أن يتم بها توافق التقنيات الحديثة مع النظام الزراعي القائم. ومثل هذه التجارب لا تسمح عادة بالتحليل الاحصائي.

يترتب على الابتكار من أهمية. ان التجارب الحقلية للثروة الحيوانية تتقدم مع الزمن وبصورة مثلى من اشراف الباحثين المطلق الى الاشراف المشترك ثم أخيراً الى اشراف المزارع الفردي على التجارب. الا أن عدم رغبة الباحث في التخلي عن التحكم وعدم ثقته في مقدرة المزارع أو في رغبته لاتباع أسس البحث غالباً ما يعوق هذا التقدم التدريجي. ويمكن تصحيح هذا الوضع ولو جزئياً على الاقل عن طريق المراجعة المنتظمة وكثرة الاتصال بين المزارع والباحث. ومن خصائص التجارب التي يشرف عليها الباحثون تصميمها الموجه نحو الحد من الاختلافات الناتجة عن عوامل خارجية وكذلك توجهها لايضاح النتائج الايجابية للمعاملات التجريبية بطريقة عملية. وبازدياد تحكم المنتجين فانه يسمح للاحوال المتصلة بالحقل ان تلعب دوراً رئيسياً مما ينتج عنه مزيداً من المتغيرية. عليه فانه يتعين أن تعدل أهداف وأسس تقييم التجارب الحقلية للثروة الحيوانية لتواكب هذا التغير في الادارة.

وكما في التجارب التي تنفذ في محطات البحوث فان التجارب الحقلية للثروة الحيوانية تتضمن عادة الشواهد التجريبية كما أنها تتميز بالاضطلاع على مجموعة شاملة من المعلومات الثانوية التي توفرها المسوحات الاستطلاعية والتي يمكن استعمالها في تقييم النتائج أو لتوضيح تأثيرات التقنية الحديثة على مناشط الحقل المرافقة. ويمكن استخدام الحقول غير المشتركة في التجارب كشواهد اذا ما أمكن تجميع المعلومات الكافية والمناسبة عنها.

تحديد المعاملات

ينبغي في التجارب الحقلية أن تجد الحلول العملية للمشاكل القائمة وذلك بحكم تعريفها، ويجب أن تصمم التجارب الحقلية على الثروة الحيوانية بطريقة تمكن المزارعين من تقييم الآثار المترتبة على ادخال التقنية الحديثة. كذلك فانه يجب ان يعد التصميم وأن تحدد المعاملات بطريقة جيدة بحيث تقود الى نتائج واضحة وسهلة التفسير. ان وجود العديد من العوامل المتداخلة جنباً الى التغيرات الكبيرة في الحقول لا يسمح باستخدام تصاميم معقدة اذ أنها تكون محدودة الفائدة تحت هذه الظروف وربما تكون التجارب ذات العامل الواحد هي الأكثر فعالية. أما عند الحاجة لدراسة عوامل اضافية فانه يجب أخذ التجارب المتوازية أو المتعاقبة في الاعتبار. أيضاً يجب تصميم معظم التجارب بحيث يمكن تقييم المعاملات التجريبية في عدة مواسم نسبة للتأثيرات الموسمية والمناخية ويمكن أخذ التجارب طويلة الأمد في الاعتبار عند حدوث تقلبات مناخية كبيرة بين السنين.

ان التحديد النهائي لعددية المعاملات التي يمكن تضمينها في التصميم يتحكم فيه عدد المكررات المطلوبة أو حجم العينة الذي يختلف كثيراً من تجربة لاخرى

بمفهومها الحالي عادة ما تستبعد اشراك المزارعين المحافظين أو أصحاب الاستثمارات الهامشية أو أولئك الذين كانت لهم خبرات سلبية مع هذا النوع من البحوث.

يمثل استعمال الحوافز أو التعويضات مكوناً عادياً من مكونات التجارب الحقلية للثروة الحيوانية كما أنها عاملاً هاماً له كل اعتبار عند اختيار الحقل. وتأخذ التعويضات ضد المخاطر التي يتعرض اليها اصحاب المواشي المتعاونين عدة اشكال منها إمداد المزارع بالعلف والحيوانات والعمالة والحصاد والنقد... الخ على أنه يجب وبصورة عامة تجنب استعمال التعويضات المادية. وقد يقود استعمال الحوافز الى تكوين عينة غير قياسية من الحقول خاصة اذا ما طبقت أسس اختيار الحقل التي تم التعرض اليها من قبل. وكما في حالة اختيار الموقع فان التقنيات الحديثة تهتم عادة بطرق فنية أو نظم عامة اذ أن المشكلة البحثية لا تكون مقصورة بأي حال على حقل بعينه كما أنه ينبغي للنتائج أن تكون قابلة للتطبيق تحت أحوال عديدة.

التحكم في التجارب

ان تنفيذ التجارب الحقلية على الثروة الحيوانية يتم عادة بتعاون المزارعين والباحثين وقد تتغير درجة التحكم عند كل طرف. ورغماً عن ان التحكم في التجارب قد يكون اكثر فعالية عند اشراف الباحثين الا ان التجارب او مكوناتها التي تكون تحت اشراف المزارع تعكس الأحوال الحقلية بصورة أفضل.

وبحكم تعريف التجارب الحقلية للثروة الحيوانية فانها تكون دائماً موجهة لخدمة المنتج ويتم اجراءها تحت شعارات: (أ) أن تكون ذات فائدة للمنتج عن طريق ادخال التحسينات على الطرق الفنية والانتاجية، (ب) يمكن للمنتج أن ينفذ التقنية الجديدة كما أنها تكون ملائمة لطريقته، و (ج) يجب أن يكون المزارع قادراً على تقييم النتائج وملاحظة قابلية التطبيق والفائدة المتوقعة. اضافة الى ذلك فان المنتج يكون عادة هو المستثمر الرئيسي للتجارب التي تجري في حقله. وتشكل هذه النقاط حججاً ودلالات على أهمية اشراك المنتج بأكبر قدر ممكن في مرحلتي اتخاذ القرار والتحكم. وفي حقيقة الأمر نجد أن مشاركة المزارعين دائماً ما تكون محدودة خاصة في مرحلة التصميم. ومن المتوقع ان تستمر مشاركة المزارع في تصميم التجارب بصورة محدودة جداً طالما يتوجب على المزارعين الاعتماد على الباحثين لتحديد المشاكل وادخال التقنيات الحديثة.

لقد تلاحظ انخفاض درجة تحكم الباحثين بعد أن تم التعرف على التجارب الحقلية للثروة الحيوانية وذلك نسبة لازدياد معرفة المنتجين للاجراءات وادراكهم لما قد

كممارسات ومواقف المزارعين، أو انخفاض في التكلفة، أو سهولة الوصول والحركة، أو وجود فرص للتحكم ومراقبة التجربة، أو امكانية التعاون مع باقي المؤسسات (كالخدمات الارشادية وموظفي الحكومة). غير أن اختيار أي موقع بناء على أسس حسية فقط يبقى أمراً مشكوكاً فيه كما أن اختيار المواقع على الأسس الشخصية آنفة الذكر لا يقلل بالضرورة من شأن البحث.

وتعتبر جميع المشاكل التي تحاول التجارب الحقلية للثروة الحيوانية ايجاد الحلول لها غير مختصة بمنطقة بعينها (الا في حالات نادرة) كما انها عادة ما تكون ذات صفة عامة تنطبق على منطقة كبيرة نسبياً. واضافة الى ذلك فان المكسب الناتج من تعاون المزارعين والتحكم في التجربة يفوق بدرجة كبيرة قيمة اختيار موقع بناء على مميزاته لتمثيل المنطقة.

ان اختيار الحقل أو المزارعين لا يختلف عن اختيار الموقع غير أن اختيار عينات في موقع معين بطريقة عشوائية بحتة أو بعشوائية مرتّبة نادراً ما يكون ممكناً. والعوامل التي تحول دون الاختيار العشوائي الحقيقي تشمل: (أ) رغبة المزارعين في التعاون واحتمال تبنيهم للابتكارات الفنية الناجحة، (ب) استيفاء شروط التضمين مع المجموعة المستهدفة، (ج) علاقة المشكلة البحثية بالمزارع، و (د) ملاءمة الحقل لكي يضمن في التصميم التجريبي اذ يجب أن يوفر الحقل متطلبات التصميم التجريبي من حيث موازنة التصميم أو عدد المكررات.

اضافة الى ما تقدم فان هناك بعض الاعتبارات الأخرى عند اختيار المزارعين كالوضع الاجتماعي وسهولة الاتصال بالشخص المسؤول عن عملية الانتاج رجلاً كان أم امرأة والرغبة الدائمة في نتائج البحوث والمشاركة السابقة في التجارب الحقلية للثروة الحيوانية. وانطلاقاً من هذا المفهوم فان توفر المعلومات الاستطلاعية هام للغاية ويجب أخذها بعين الاعتبار عند اجراء عملية الاختيار.

ومن وجهة نظر المزارعين يتم تقييم الفوائد المتوقعة من المشاركة في التجارب الحقلية للثروة الحيوانية بمقارنتها مع المخاطر اذ ان ابداء المزارع رغبة في التعاون يعني أنه يأمل في منفعة قد تعود عليه من التجربة أو أنه لن يتكبد خسارة على أقل تقدير. ويمكن للفوائد المتوقعة أن تكون في شكل تطبيق مستقبلي للتقنية الحديثة حيث يعتبرها المزارعون حلاً ناجعاً لمشكلة تواجههم. ومن الناحية الأخرى فقد يتوقع المزارعون الاستفادة من الحوافز أو التعويضات التي يوفرها الباحثون أو لما يصاحب الاشتراك في هذه التجارب من نفوذ وهيبة. ان التجارب الحقلية للثروة الحيوانية

تصميم التجارب الحقلية

ج. إ. فان آيز

معهد البحوث للانتاج الحيواني، البرنامج التعاوني لدعم أبحاث المجترات الصغيرة، ص ب (٢١٠)، بوقر، اندونيسيا

ان تصميم التجارب والاجراءات التي تستخدم لتنفيذها في محطات البحوث غالباً ما تكون غير ملائمة لظروف الحقل الشديدة التغير، كما وان عدم امكانية التحكم في أوضاع الحقل المعقدة يجبر خبراء التجارب لايجاد مدخل للتوفيق بين عدم مرونة تصميمات التجارب للايفاء بالمتطلبات العملية من ناحية وبالدقة المطلوبة من الناحية الأخرى.

وفي محاولاتهم للوصول الى نسبة أكبر للتحكم ولتسهيل عملية تفسير النتائج فان الباحثين يدركون جيداً انه يجب تجميع المعلومات الأساسية عن الحقل وظروف الانتاج. عليه فانه يمكن تعويض فقدان جزء من عدم المرونة في التجارب بالمعلومات الاضافية التي يتم اكتسابها عن المتغيرات التي تؤثر على درجة الاستجابة. وتعتبر مرحلة التشخيص (أو مرحلة الوصف الدقيق) ذات أهمية بالغة بل انها أضحت روتيناً مسلماً به للكثير من التجارب الحقلية. وتستخدم نتائج هذا الاستطلاع في اختيار المواقع والحقول وفي اعداد تصاميم التجارب المناسبة.

اختيار الموقع والحقل

ان اختيار موقع أو أكثر لتنفيذ البحث يمثل الخطوة الأولى في التجارب الحقلية للثروة الحيوانية. ولقد بات مفهوماً أنه يتحتم في مثل هذه المواقع أن تكون ممثلة لأحوال بيئة زراعية معينة وأن تعكس بصورة مثلى نظام الانتاج في المزارع المستهدفة. وقد يصعب تعريف ماهية التمثيل بالرجوع الى هذه الأسس ولكن وبحكم الممارسة فان الاختيار يتحدد غالباً عن طريق حجج وبراهين بديلة ولكنها متساوية في القوة

توجيه لمشاكلهم) . أيضاً فان التعريف غير الواضح أو المتأخر «للمجموعة المستهدفة» يمكن أن يؤدي الى تبديد موارد البحث اذ يستمر الباحثون في اعداد التقنيات التي تلائم مجموعات لا تتواجد الا في الخيال .

أما في داخل المجموعات المستهدفة فيجب التعريف بالعاملين الرئيسيين والذي يعتمد بدوره على نوع التقنية التي يتم اختبارها . وعلى سبيل المثال فان الأزواج في بعض الحالات يمثلون المجموعة المستهدفة وفي حالات أخرى، تكون الحاجة ملحة لمقابلة الزوجات أو المالكين أو المستأجرين أو حتى الأطفال حيث أن الزراعة تمثل نشاطاً يمارسه جميع أفراد الأسرة .

ان التعريف الواضح بالمشكلة البحثية والمجموعة المستهدفة وأهداف التجارب وأغراضها يمثل الأساس الذي يحدد تصميم التجربة الحقلية ومدى مشاركة المزارعين فيها والأسس التي يتم بواسطتها تقييم النتائج . ومن المنطقي أن تختلف كل هذه السمات من تجربة لأخرى استناداً على تعريف المشكلة المعينة وعلى أهداف التجربة المصرح بها .

المزارعين، و (ج) التجارب التشجيعية (بيانات عملية). ان التجارب التي يشرف عليها الباحثون غالباً ما تكون محصورة في قياس الأبعاد والمتغيرات الفنية ويمكن أخذ التجربة الخاصة باضافة العناصر المعدنية في تغذية الحيوانات في غرب جاوا كمثال. أما التجارب التي يشرف على ادارتها المزارعون أنفسهم فتسمح بأخذ مقاييس المتغيرات السلوكية اضافة الى الأبعاد الفنية والتي قد تقود الى «معاملات عفوية» أو تعديلات فنية ودلالة على ذلك نجد أن المزارعين الذين يختبرون ادخال زراعة الأشجار مع المحاصيل الحقلية في جنوب غرب نيجيريا قد حاولوا حرق النفايات واستخدام الجرارات في الحراثة وادخال محاصيل بديلة وزراعة الأشجار تحت الظل وقد نجحوا في كل محاولاتهم تلك ما عدا الزراعة تحت الظل.

أما في اثناء اجراء التجارب التشجيعية والبيانات العملية فانه يمكن فقط رصد استجابة المزارعين حيث أن الحزمة التقنية تكون كاملة التفاصيل وواضحة الملامح بحيث لا تسمح الا باجراء تعديلات طفيفة وهامشية.

المجموعة أو المنطقة المستهدفة للدراسة

رغماً عن وجود أكثر من اتجاه لأبحاث النظم الزراعية الا أنها جميعاً تتفق على تعريف المجموعة أو المنطقة المستهدفة للدراسة (نطاق بيئي مثلاً). والامثلة على المجموعات المختارة للتجارب الحقلية للثروة الحيوانية تشمل مزارعي المجترات الصغيرة بغرب جاوا وغرب نيجيريا الذين يتبعون لبرامج المجترات الصغيرة بكل من برنامج دعم الأبحاث التعاونية ومركز المواشي الدولي لافريقيا على التوالي، وكذلك أصحاب الثيران بأثيوبيا. ومن الناحية الاخرى نجد أن مشروع الرهد الزراعي بالسودان يمثل منطقة معينة مستهدفة للدراسة.

على كل فان انعدام وجود تعريف للمنطقة المستهدفة يجب أن يحظى بالاهتمام اذ أنه وفي كثير من الأحيان يتم تعريف المجموعة المستهدفة للدراسة (أو منطقة التوصية) بعد أن يتم اعداد التقنية (مبدئياً) ومن ثم يتم تحديد المجموعة التي يمكنها الاستفادة من هذه التقنية هذا اذا لم تتم متابعتهم للتسليم بهذا الوضع. عليه فانه يفترض في «المجموعة المستهدفة» ان تلائم التقنية وليس العكس. والتجربة الحقلية على تحضير الدريس بالسودان لهي خير مثال على ذلك. لقد كان أصحاب الثروة الحيوانية المتنقلين في الأصل جزءاً من «المجموعة المستهدفة» الا أنه أضحى واضحاً وبعد مرور عام واحد أن تقنية تصنيع الدريس لا تناسبهم وبالتالي فقد تم استبعادهم من «المجموعة المستهدفة» (هذا لا يعني ان جزءاً مهما من برنامج البحث لم يتم

ملاحظتها بواسطة الباحثين أنفسهم. ان برنامج البحث الخاص بادخال الماعز ثنائي الغرض بكينيا قد تم توجيهه للتغلب على مشكلة نقص البروتين الحيواني في الغذاء المحلي للسكان. كذلك فان المشكلة الناتجة من عدم الاستفادة من مخلفات التصنيع الزراعي بالسودان يمكن تضمينها في هذه المجموعة. ورغماً عن أن الباحثين يمتازون على غيرهم بمعرفتهم للطاقة البحثية المتوفرة الا أنهم دائماً ما يميلون الى ترك مهمة تحديد موضوع البحث الى الامكانيات المتوفرة (مثل تجارب التغذية المستمرة) بالاضافة الى طريقة البحث.

ويمكن اعتبار المجموعة الأخيرة من المشاكل أكثر المجموعات اثارة للانتباه وذلك لأنه لم يتم اكتشاف هذه المشاكل حتى هذه اللحظة. ففي مثل هذه الحالة يكون الهدف من التجربة الحقلية هو ممارسة بعض النشاط (البحثي) بالتزامل مع المزارعين لكي يتم التفهم الكامل لأنظمتهم الزراعية ولتحديد مشاكلهم. وهذا التحديد يكون نتاجاً لعملية متكاملة تبدأ بأن يحدد الباحثون الاطار العام للمشكلة ومن ثم تبدأ عملية التعريف واعادة التعريف للمشكلة (أو المشاكل) في تعابير دقيقة ومحددة. واستخدام قطيع تابع لمحطة البحث ووضعه مع قطعان الرعاة المتنقلة بالسودان يعتبر مثالاً لهذا النوع من النشاط البحثي. وبالتأكيد فان أثمن النتائج التي تتمخض عنها التجارب الحقلية تتمثل في معرفة أفضل للمعوقات الادارية، فقد أوضحت التجارب التي أجريت في حظائر التسمين بالخرطوم وجود بعض المشاكل الصحية لدى الحيوانات كانت مجهولة حتى وقت اجراء التجارب. ان جهل الباحثين للكثير من المعلومات المتعلقة بممارسات المزارعين في المجالات المفوضة للبحث يمثل واحداً من أهم المبررات لاجراء البحوث الحقلية.

ويلزم التنويه الى أن التجارب الحقلية ليست بالضرورة أحسن وسيلة لمواجهة أي من المشاكل البحثية السابق ذكرها. بل ان التقييم المسبق (كاستعمال الميزانية الجزئية أو بواسطة المناقشات مع المزارعين مثلاً) قد يؤدي في بعض الأحيان الى اعادة تصميم التجربة أو الى المزيد من العمل في محطة البحث أو حتى الى الاستغناء الكامل عن التقنية المعنيّة وشطبها من برنامج البحث. عليه فان الحرص على تنقية وتمحيص التقنيات قبل اجراء التجارب الحقلية يقود الى استعمال أمثل للموارد البحثية الشحيحة.

أنواع التجارب

لقد تم تصنيف ثلاثة أنواع من التجارب الحقلية على وجه العموم وتشمل (أ) التجارب التي يشرف على ادارتها الباحثون، (ب) التجارب التي تحت اشراف

هذا الاتجاه أن يقوم الباحث بعمل خارج نطاق التفويض البحثي المتفق عليه من قبل. والبحث الذي يهدف الى تحسين الوفرة الغذائية خلال موسم الجفاف يمكن أن يكون مثالاً أقل اثارة للجدل لمشكلة بحثية تناسب تماماً احتياجات المزارعين (حسب إدراكهم لها) . غير أن واحداً من أكبر مساوىء الاعتماد على تقييم المزارعين للمشاكل المحيطة بهم تتمثل في جهلهم لامكانيات البحث ومعوقاته واحتمالات عدم مقدرتهم على التنبؤ بنوعية المشاكل المتوقعة (كتدهور خصائص التربة) أو الخيارات المستقبلية (كالانفتاح على أسواق جديدة) .

ثانياً ، ان العديد من الدراسات تعرضت لمشاكل تم تحديدها بواسطة الحكومة (وبالتعاون مع وكالات التنمية في كثير من الأحيان) وتمثل هذه المشاكل الأساس الذي تبنى عليه المشاريع الحكومية . والدراسة التي أجريت عن انتاج الألبان بالسودان وتلك عن معاملة القش بالأمونيا واليوريا في مصر يمثلان هذه المجموعة .

ان استخدام التجارب الحقلية في المشاريع الحكومية يثير عدة تساؤلات تتعلق بحقيقة أهداف هذه التجارب من حيث مفهومها الواضح من جهة أو كونها مجرد مقياس لمدى استجابة المزارعين لتقنية بعينها (وربما تكون ثابتة) كجزء من التقييم الكامل للمشروع من جهة أخرى . وفي المناقشات الخاصة بالآثار الايجابية والسلبية للربط بين التجارب الحقلية للثروة الحيوانية ومشاريع التنمية الحكومية تم ابراز العديد من المزايا لمثل هذه الصلة حيث أن الفرص مواتية لنجاح التجارب الحقلية لأسباب تتمثل في (أ) وجود التزام طويل الأمد تجاه المنطقة المعنّية أو السكان المعنيّين ، (ب) توفر الدعم الفنيّ والتمويني في أغلب الأحيان ، و (ج) امكانية المتابعة الارشادية والتي قد تساعد في اشباع تطلعات المزارعين المتعاونين . ومن الناحية الأخرى فان مشاريع التنمية الحكومية تساهم أحياناً في ترقية التقنيات المقترحة من قبل والتي لم تعدل لتناسب الأحوال بالمنطقة كما أنها لم تختبر بطريقة مثلى . واذا ما ترددت سلطات المشروع في اعادة تصميم التوصيات فان هذا يجعل المجهودات البحثية عديمة الجدوى علماً بأن الاختلافات بين أهداف المشروع وأهداف المزارعين قد تؤثر على استجابة المزارعين أو على رغبتهم في التعاون . وفي حالة مشاركة الدولة الفعلية ودعمها للأسعار فان التقييم الحقلي قد يؤدي الى نتائج مؤقتة يعتمد بقاؤها فقط على استمرار الحكومة في المحافظة على المساهمة والدعم . أما بالنسبة للاستعمال الروتيني للتجارب الحقلية بغية الرصد والتقييم من داخل مشاريع التنمية فانه يهيىء أحسن الفرص للحد من الاستعمال غير الفعّال للموارد القومية .

أما المجموعة الثالثة من المشاكل التي تم التطرق اليها فهي تلك التي لم يحددها المزارعين كما أنها غير مرتبطة بالسياسة الحكومية أو مشاريع التنمية ولكن تمت

ملخصات منهجية البحوث

تعريف المشاكل البحثية

هـ. كنبشير

وينروك انترناشونال: موريلتون، أركينساس ٩٥٣٧ — ٧٢١١٠،
الولايات المتحدة الامريكية

ان التجارب الحقلية على الثروة الحيوانية ليست غاية في حد ذاتها كما انها ليست الوسيلة الوحيدة لدراسة مشاكل المزارعين أو لتحسين النظام الزراعي بل ومن الواضح انها غير مناسبة لمعالجة أنواع عديدة من المشكلات. عليه فان التركيز على التجارب الحقلية يعنى بالضرورة حصر وتحديد أنواع المشاكل التي يمكن التعرض لها.

لقد بات واضحاً أن اجراء التجارب الحقلية ليس مقصوراً على الباحثين فقط وانما يمكن اجراؤها بواسطة العاملين في الارشاد وضباط التنمية وأهم من هؤلاء جميعاً المزارعون أنفسهم. وبما أن للأشخاص والمنظمات التي تشارك في تنفيذ التجارب الحقلية على الثروة الحيوانية ميولاً للتأثير على الكيفية التي يتم بها فهم وادارك نوعية المشاكل السائدة وكذلك على أنواع التجارب المنفذّة لذا يمكن تقسيم أوراق العمل والدراسات التي أعدت لهذه الحلقة الدراسية الى اربع مجموعات استنادا على الطرق التي تم عن طريقها فهم وادراك أبعاد المشاكل وهي اما بواسطة المزارعين أو بواسطة الدولة أو بواسطة الباحثين أو بواسطة «لاأحد» وهذا التقسيم غير شامل بأي حال من الأحوال كما أنه ليس كاملاً.

أولاً، هنالك تجارب حقلية تعالج احتياجات المزارعين الملموسة حيث يحاول الباحث أن يحس ويستجيب بطريقة مثلى لاحتياجات المزارعين التي يتم تصنيفها معهم أو مع أسرهم. ومن الممكن أن يمثّل لهذا الاتجاه بالعمل الذي أنجز في جنوب غرب نيجيريا بواسطة مركز المواشي الدولي لأفريقيا. ولكن ربما ينجم من المغالاة في

بنسبة خمسين بالمائة مما أسفر عن وجود مشكلة تسويق خطيرة في مواجهة انتاج المطحنة رغماً عن رخصه . ونسبة لارتفاع أسعار الذرة والكسب المفاجىء وبنسب غير متوقعة مما أدّى الى تقلص أرباح المنتجين بل وان بعضهم قد تكبدّ بعض الخسائر المادية ، فان هذه الدراسة تهدف الى انتاج غذاء بديل تنتجه المطاحن ويكون متميزاً بقلة التكلفة وتكامل العناصر ويحوز على رضا أصحاب حظائر التسمين في ذات الوقت .

ولتحقيق أهداف البحث تم اجراء استطلاع غير رسمي اشترك فيه عشرة من أصل ثمانين منتجاً كما أجريت بعض التجارب على نوع العلف الذي تنتجه المطحنة الا أن هذه التجارب لم يكتب لها النجاح . عليه ، فقد قدم اقتراح لاستعمال نوعين من العلف حيث يكون الأول بمثابة غذاء تنشيطي غني بالبروتينات ويستعمل الثاني في المرحلة النهائية حيث انه يكون غنياً بالطاقة على أن يتم انتاج هذه الأغذية بواسطة مطحنة كبّرو . وبالفعل فقد تم بيع العليقة الجديدة هذه الى اثنين من المنتجين بسعر التكلفة الا أن واحداً منهما لم يلتزم بالاستمرار في التجربة حتى نهايتها . عليه فقد تم تقسيم ماشية المنتج الآخر الى مجموعتين بطريقة عشوائية حيث تمت تغذية مجموعة بالطريقة التقليدية بينما استعملت الطريقة المقترحة لتغذية المجموعة الاخرى . وقد تم تحديد درجة التسمين بطريقة ذاتية . ورغماً عن أن الأغذية المقترحة قد استغرقت خمس وعشرين يوماً اضافياً مقارنة بالطريقة التقليدية الا أن جملة التكلفة كانت أقل مما حدا بالمزارع أن يشتري مائة طن اضافية من العليقة التنشيطية .

لقد تقرر اعادة التجربة ولكن باستراتيجية مختلفة تأخذ بعين الاعتبار موجة الجفاف التي تسود المنطقة حالياً حيث تقرر عدم استعمال الذرة لتغذية الحيوانات حيث أنها تستعمل في غذاء السكان كما قدمت مقترحات لمصادر أخرى للطاقة . وقد أعلن ثلاثة منتجين آخرين موافقتهم على الاشتراك في التجارب التي تم تخطيطها بينما تقوم المطحنة بتوفير الأغذية المطلوبة . وسيتم تقييم الأغذية بطريقة حاسمة وذلك باستعمال مقاييس حسّية لأداء الحيوانات .

النوع من التقنية الحديثة بدءاً باستعمالها في حقول البحث والبحوث التكميلية في محطات البحث والتقييم الذي استعملت فيه النماذج المقلدة والتجارب الحقلية.

لقد استعمل تسعة من صغار المالكين في منطقة ديبرى — زت أبقارهم المهجنة في فلاحة الأرض بمحض ارادتهم متحملين لكل المخاطر والتكاليف التي قد تنتج من جراء هذا العمل. وقد كانت نتائج التجارب مشجعة وأوضحت أن استخدام الأبقار لجر الآلات الزراعية لا يؤثر على انتاج اللبن كما أنه لا توجد مشاكل منظورة تحول دون اتباع هذا النوع من الاستخدام.

من أهم المشاكل التي واجهت التجارب الحقلية الخاصة باستعمال الابقار للجر تلك التي تتعلق بنوعية طرق البحث حيث أن طبيعة الاستثمار الحيواني بالمنطقة تعتمد على تعدد المنتجات مما يصعب معه تحديد قيمتها الحقيقية وكذلك الحال بالنسبة للتقديرات الاحصائية التي تتطلب توفر عينات بعددية أكبر مما يسمح به عدد الأبقار المتواجد في التجربة الحقلية وأيضاً التباين الملحوظ في مقدرات المزارعين الادارية والموارد الأساسية مما يؤدي الى اختلافات في طريقة تسيير العمل بكل حقل.

تهدف الأبحاث التي ستجرى مستقبلاً الى زيادة أعداد المزارعين لاختبار التقنية والتي ستدعم بأبحاث تفصيلية في محطات البحوث وذلك بالرجوع الى مشاكل الانتاج التي تواجه المزارعين وعلى وجه التحديد فان التركيز سيكون على مدى تداخل وتأثير عمل الحقل وانتاج اللبن وتوالد الأبقار على بعضها البعض خاصة في مراحل الانتاج الحرجة وتحت أنواع مختلفة من التغذية.

انتاج لحوم الماشية باستعمال مخلفات التصنيع الزراعي: تجارب في حظائر التسمين الخاصة

عبد الفتاح ى. م. نور و ف. أ. حمزة

شعبة علم الحيوان، كلية العلوم الزراعية، جامعة الجزيرة، ص ب (٢٠)، واد مدنى، السودان

الخلاصة: تعتمد الطريقة التقليدية التي يتبعها القائمون بأعمال حظائر التسمين في أواسط السودان على استعمال الذرة والكسب في تغذية الماشية عوضاً عن العلائق التي تنتجها مطحنة اتحاد المزارعين بكبّرو والتي تحتوي على نخالة القمح

أسست تجارب الرعي في ثمانية حقول وذلك لمقارنة انتاجية النعاج من اللبن حيث قسم قطيع كل مزارع الى ثلاث مجموعات متشابهة التكوين خصصت مجموعتان منها لرعي البيقة والجلبان بينما استعملت المجموعة الثالثة كشاهد حيث تركت في المراعي المشاعة. وقد تم قياس كميات اللبن المنتجة ووزن النعاج بصورة منتظمة وبمساعدة المزارعين. هذا وما تزال تجارب تكميل الدورة والاستطلاعات مستمرة بهذه المنطقة.

أيضا فقد تم تأسيس تجارب الحصاد في نصف هكتار لكل من محصول البيقة والجلبان في اثني عشر حقلاً تم فيها رصد احتياج المزارعين للعمالة وتكلفة الحصاد. ولقد ضمت كل تجربة حصاد مقسمات بمساحة (٢ر٠) هكتار تم تصميمها ضمن دورة بحيث يمكن قياس درجة الاستجابة للتسميد عند الجلبان والبيقة والعدس والشعير، والشعير المضاف اليه الآزوت وكذلك لمتابعة الآثار المنعكسة على محصول الشعير الذي يزرع في الموسم التالي.

استخدام ماشية اللبن المهجنة للجّر: خبرات من الأراضي المرتفعة بأثيوبيا

جيدو قريسيلز و فرانك أندرسون

مركز المواشي الدولي لافريقيا (إلكا)، ص ب (٥٦٨٩)، أديس أبابا، إثيوبيا.

الخلاصة: تمتلك أثيوبيا أكبر ثروة حيوانية في منطقة شبه الصحراء الأفريقية. ونظراً لأهمية الماشية كمصدر للقوة الساحبة (الجر) نجد أن الثيران الجاهزة للعمل وتلك التي في طور الاعداد تمثل نسبة كبيرة من جملة الحيوانات التي يحوزها صغار المالكين. واذا ما أمكن استخدام الأبقار كطاقة للجر فضلاً عن الثيران ودونما أن يكون هنالك تأثير فعلي على انتاجها فانه من شأن هذا الاتجاه أن يخلق فرصة طيبة لاعادة تركيب قطعان صغار مالكي الثروة الحيوانية.

تبرز هذه الورقة تجارب مركز المواشي الدولي لافريقيا في استخدام الأبقار المهجنة كحيوانات عمل كما تشرح المدخل التدريجي الذي تمت من خلاله تجربة هذا

وطرق انتاجها بينما حدد الآخران لتقييم انتاج كل من العلف واللبن . هذا ، وقد أبدى المزارعون تفهماً كاملاً لأهداف التجارب كما أظهروا تعاوناً تاماً في تنفيذها .

أوضحت النتائج أنه رغماً عن امكانية حصول المزارعين على انتاجية معقولة للأعلاف الا أنها لا تستخدم بالطريقة المثلى نسبة لوجود بعض الأسباب العملية التي تحول دون ذلك . من هنا نجد أن التجارب الحقلية كانت وسيلة قيّمة لتكميل المعلومات التي جمعت عن ممارسات المزارعين بواسطة طرق أخرى وفي ذات الوقت حققت الهدف الذي يرمي الى تحديد طرق انتاج أفضل ومتاحة للمزارع في آن واحد .

أخيرا ، فان الثقة بالنفس التي اكتسبها المزارعون الذين اشتركوا في تنفيذ التجارب وجيرانهم اضافة الى ايمانهم باهمية العمل الذي يقوم به فريق البحث ليقف انجازاً متكاملاً لهذا النوع من طرق البحث .

التجارب الحقلية في شمال غرب سوريا : اختبار امكانية استعمال الأعلاف البقلية الحولية للرعي والتخزين

**دينيس تلي(١) ، ايوان . ف . تومسون(٢) ، رونالد جوبيرت(١) ،
و توماس . ل . نوردبلوم(١)**

(١) برنامج النظم الزراعية ، و (٢) برنامج المراعي والأعلاف والمواشي ، المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا) ، ص ب (٥٤٦٦) ، حلب ، سوريا .

الخلاصة : يمثل الشعير المحصول الرئيسي في المناطق السورية التي تتراوح أمطارها السنوية بين ٢٠٠ و ٣٥٠ مليمترا وتكون زراعته اما متتالية سنة بعد الأخرى واما بالتبادل مع البور . أما بالنسبة لمحاصيل الأعلاف البقلية كالبيقة والجلبان فانها تزرع في مساحات صغيرة وذلك لضعف انتاجيتها من ناحية وللتكلفة العالية للبذور وعمال الحصاد من الناحية الأخرى . ولقد تم تخطيط مجموعتين من التجارب لقياس مقوّمات الانتاجية والتكاليف والمعوقات التي تواجه الدورات التي تتضمن انتاج محاصيل العلف البقلية لرعيها في الربيع أو لحفظها كعلف شتوي بعد أن تحصد عند اكتمال نضجها .

بالنسبة لمعاملة القش باليوريا فنجدها قد كانت أكثر ملائمة لصغار المزارعين رغماً عن ازدياد متطلبات العمالة والماء.

أكدت هذه الدراسة على أهمية النشاط الارشادي كأداة لنقل ونشر التقنيات الحديثة. كذلك فقد تم قياس استجابة المزارعين للفوائد المكتسبة والمشاكل التي واجهتهم عند التطبيق.

وأخيرا، فان التجارب الحقلية قد برهنت على أنها أداة فعّالة لفحص درجة تبنّي التقنية الحديثة وذلك عن طريق قياس قابليتها للتطبيق ومستوى أداء الحيوانات واستجابة المزارعين.

التجارب الحقلية على الأعلاف الصيفية المروية في مزارع الألبان الصغيرة بمشروع الرهد الزراعي بالسودان

ر. س. مضوى(١)، ع. ي. م. نور(١)، ع. ح. احمد(٢)،
ع. ب. محمد(١) و آ. ص. ابراهيم(٣)

(١) كلية العلوم الزراعية، جامعة الجزيرة، ص ب (٢٠) واد مدني، السودان، (٢) برنامج النظم الزراعية، ايكاردا، ص ب (٥٤٦٦)، حلب، سوريا، و (٣) كلية الزراعة، جامعة الأمارات العربية المتحدة، ص ب (١٥٥٥١)، العين، الأمارات العربية المتحدة

الخلاصة: خصص مشروع الرهد الزراعي بالسودان مساحة (١٦٨٠) هكتاراً لانتاج محاصيل الأعلاف للاستفادة منها في تغذية حوالي (١٠٨٠٠) رأس من ماشية الألبان. وقد بدأ تقسيم الحيازات التي تبلغ مساحة كل منها (٢ر٤) هكتاراً في موسم ٨٢ /١٩٨٣. وبما أن التجارب الحقلية تمثل ركناً أساسيا في مشروع البحث الذي يرمي الى تحسين نظم انتاج الألبان بالمشروع فقد تحدد الهدف الأول لهذه التجارب في مساعدة الباحثين لتكوين صورة واقعية عن نظم الانتاج التقليدية اضافة الى تحديد وادخال طرق عملية لتحسينها.

لقد تم اختيار خمسة من المزارعين لتنفيذ التجارب الحقلية في السنة الأولى حيث تم تحديد ثلاثة منهم لاجراء التجارب الخاصة بتقييم انتاجية محاصيل الأعلاف

لقد أثبتت النتائج أن اضافة العناصر المعدنية أدى الى زيادة الوزن قبل وبعد الفطام علاوة على خفض نسبة النفوق في كلا القريتين بينما لم يكن هنالك أي تأثير لعنصر اليوريا. هذا وقد كانت زيادة الوزن بعد الفطام في خمس حيوانات بكل حقل أفضل قياس لدرجة تأثير إضافة العناصر المعدنية من الزيادة قبل الفطام. أيضا فقد وجد أن ست حقول لكل معاملة في كل من الموقعين طيلة فترة الدراسة البالغة تسعة أشهر كانت كافية لاكتشاف اختلافات المعاملة بالنسبة الى عشرين بالمائة من زيادة الوزن بعد الفطام غير أن اكتشاف اختلافات أصغر حجماً يحتاج الى أعداد خيالية من الحقول.

تجارب حقلية على استخدام القش المعامل بالأمونيا بمصر

ح. ياقوت، م. حتحوت، ح. النوبي و ت. ج. باركر

معهد بحوث الانتاج الحيواني، مركز البحوث الزراعية، وزارة الزراعة، الدقي، الجيزة، مصر.

الخلاصة: لقد أصبح بالامكان زيادة القيمة الغذائية لمخلفات المحاصيل الحقلية (كقش الأرز) اثر معاملتها بالنشادر (الأمونيا) حيث وجد مشروع لحوم الأبقار بمعهد بحوث الانتاج الحيواني تحسناً ملحوظاً في متوسط الكميات المستهلكة ومعدل النمو اليومي لحيوانات التسمين عند استخدام القش المعامل بالأمونيا وبالتالي فقد استخدمت هذه النتائج لتشجيع استعمال الأمونيا بواسطة المزارعين.

ولمعرفة مدى استجابة المزارعين لاستعمال التقنيات الحديثة فقد تم اختيار ثلاثين من مزارعي محافظة البحيرة الذين يستعملون الأمونيا او اليوريا حيث أوضح لهم خبراء المشروع طريقة الاستخدام المثل عن طريق البيان العملي ومن ثم تمت عملية متابعتهم من خلال زيارات منتظمة بهدف تجميع المعلومات ورصد ما يحرزونه من تقدم وذلك باستخدام استمارات استبيان خصصت لهذا الغرض.

أبرزت النتائج أنه بامكان المزارع أن يوفر مقدار ثلاثة أطنان من الأعلاف المركزة في مقابل استعمال عشرة أطنان من القش المعامل بالأمونيا. ومن أهم المشاكل التي واجهت المشروع امتناع صغار مزارعي الألبان عن الافصاح بمعدلاتهم الانتاجية بينما واظب كبار المزارعين ومزارع القطاع العام على توفير المعلومات المطلوبة. أما

خاصة لفترات زمنية طويلة بهدف تجميع المعلومات فان هذا يؤدي الى تردد واحجام الرعاة عن السماح للباحثين بالتحكم في حيواناتهم نسبة لما يعنيه هذا التدخل من اعاقة لروتين ادارتهم اليومي .

ان تجربة مشروع تطوير البحوث الزراعية لغرب السودان مع القطعان المترحلة التي تمتلكها محطات البحوث والتي تمثل القطعان التقليدية من حيث التكوين والادارة كانت ثرة جداً حيث مكنتّ المشروع من تحقيق عدة أهداف تمثلت في (١) اجراء الدراسات التشخيصية لمعرفة نمط الانتاج ومشاكله و(٢) تخطيط وتصميم وتنفيذ تجارب يشرف عليها الباحثون و(٣) زيادة التقارب بين الباحثين والرعاة مما يمكن الباحثون من التعرف على مشاكل الرعاة ويمكن الرعاة من التعرف على الوسائل والطرق البحثية التي يستخدمها الباحثون مما تمخض عنه تنفيذ تجارب تطبيقية عن طريق استخدام حيوانات المنتجين .

التجارب الحقلية الخاصة باضافة العناصر المعدنية لغذاء المجترات الصغيرة في غرب جاوا بأندونسيا

ج . ا . فان آيز(١،٢) ، س . سليتونقا(١) ، ا . و . ماثياس(١) ، و و . ل . جونسون(٣)

(١) معهد البحوث للانتاج الحيواني، البرنامج التعاوني لدعم أبحاث المجترات الصغيرة، ص ب (٢١٠)، يوفر، اندونيسيا، (٢) حاليا مع جامعة ولاية كارولينا الشمالية، و (٣) جامعة ولاية كارولينا الشمالية، ص ب (٧٦٢١)، رالى، كارولينا الشمالية ٢٧٦٩٥ ، الولايات المتحدة الأمريكية .

الخلاصة : أجريت تجارب حقلية لتكميل عليقة الأغنام والماعز بالعناصر المعدنية واليوريا في قريتين بجزيرة جاوا الأندونيسية استعمل فيها نظام تسجيل ومراقبة تم انشاؤه أثناء المرحلة التشخيصية خلال سنتين سابقتين. وقد أوكلت مهمة المراقبة والتحكم اليومي لفريق يتكون من رجلين يقيمان بشكل دائم في القريتين. طبقت خمس معاملات مختلفة من حيث تركيز العناصر المعدنية واليوريا على حيوانات خمس وعشرين مزارعاً في كل قرية حيث تم استعمال معاملة واحدة فقط بكل حقل. وقد كانت العلائق التكميلية على شكل كتل من المولاس ونخالة الأرز قدمت مجاناً للمزارعين بينما استعملت أساليب حقلية لمعرفة الزيادة في الوزن قبل وبعد الفطام لقياس درجة تأثير هذه الاضافة .

تم اختيار عينة عشوائية مكونة من ثمانين مزارعاً من عينة قومية أكبر لصغار المزارعين في غرب كينيا. وقد بدأت التجارب بادخال أعداد محدودة من الماعز ثنائي الغرض وعندما توفر الماعز باعداد أكبر تمت زيادة المزارعين المتعاونين اضافة الى زيادة اعداد الماعز ثنائي الغرض بكل مزرعة. وتضمّن الرصد الحقلي على زيارات نصف شهرية بواسطة كبار الباحثين وزيارات أسبوعية بواسطة فنيو حقل مدربين ومجيدين للغات المحلية. وقد تم تجميع البيانات الخاصة بمتغيرات أداء الماعز ثنائي الغرض كالرضاعة ونظم الحلابة واختيار الغذاء والاستهلاك من الأراضي غير المزروعة وتغيرات وزن الجسم وتداخل التغذية والمنافسة بين الماعز ثنائي الغرض والحيوانات الحقلية الأخرى باستعمال الاستبيانات والملاحظات التي توفرها التجارب والتحقيقات الرسمية وغير الرسمية مع المزارعين. وتمت مناقشة البيانات التي تم الحصول عليها في اجتماعات اسبوعية ضمت علماء البحوث وفنيّ الحقل قبل تسجيلها في الكومبيوتر توطئة لتحليلها لمعرفة الامكانية الفنّية والحيوية الاقتصادية والانسجام الاجتماعي لتقنية الماعز ثنائي الغرض في النظم الزراعية الضيقة النطاق.

استخدام القطعان المترحلة لدراسة النظم الرعوية الانتشارية

ب. فضل الله و ريتشارد هـ. كوك

مشروع تطوير البحوث الزراعية لغرب السودان، هيئة البحوث الزراعية، ص ب (٥١٤١)، الخرطوم جنوب، السودان

الخلاصة: ان انشاء قطعاناً من المواشي تابعة لمحطات البحث لكنها خاضعة لادارة مشابهة لتلك التي نجدها سائدة في النمط الزراعي الرعوي المراد دراسته يمكن أن تكون أداة فعالة لاجراء بحوث تتعلق بالنظم الرعوية الانتشارية. ولكي نتمكن من ايجاد بدائل مناسبة تؤدي الى رفع انتاجية مزارعي القطاع الرعوي لابد لنا من معرفة معوقات الانتاج الرئيسية والكيفية التي يعيد بها المنتجون ترتيب مواردهم لتحقيق أهدافهم الانتاجية. ولضمان قبول وتبنّي البدائل والتقنيات الحديثة بواسطة المنتجين يجب أن يبرهن تفوقها على الممارسات الرعوية الحالية. وبما أن تشخيص وتصميم واختبار التقنيات الحديثة قد يتطلب اختيار عينات من الحيوانات ومعاملتها بطريقة

والألياف الخام والرماد تبلغ ١٣ر١٧ و ٣١ر٥٦ و ١٦ر٧٧ بالترتيب لعلف الفيل وتبلغ ١٢ر٢٩ و٢٦ر١٣ و١٢ر١٨ للسوردان كما تبلغ ١١ر٩٢ و٣٢ر٠٨ و١٠ر٧٢ للدراوة. كذلك أثبت تحليل المادة الجافة من سائل الكرش أن القيمة الغذائية تمثل ٦٠ر٥٣ و٥٣ر٥٢ و٦٣ر٤٣ بالمائة لعلف الفيل والسوردان والدرواة على التوالي.

بلغت جملة تكاليف العمليات الزراعية للهكتار ١٣٥٤ر٧٦ و ١١٣٨ر١٠ و٦٤٧ر٦٢ جنيهاً مصرياً (واحد دولار أمريكي = ١ر٢٥ جنيهاً مصرياً) لكل من علف الفيل والسوردان والدراوة على التوالي. وقد أوضحت الدراسة أن علف الفيل يأتي في المقدمة من حيث العائد النقدي للهكتار (حيث بلغ ١١٤٢ر٨٦ جنيهاً مصرياً) يليه السوردان (بعائد نقدي قدره ٦٤٧ر٦٢ جنيهاً مصرياً) وأخيراً تأتي الدراوة (حيث بلغ عائدها ٤٩٧ر٦٢ جنيهاً مصرياً) لكونها تعطي محصولاً واحداً فقط في الموسم. كذلك فقد تم رصد مواقف المزارعين نحو جدوى زراعة واستهلاك الأعلاف الصيفية التي أدخلت حديثاً.

تجارب حقلية على الماعز ثنائي الغرض في المزارع الصغيرة بغرب كينيا

أ. ت. سيد احمد(١،٢)، ج. ف. م. أونيم(١،٢)، أ. و. مخيبي(١،٢)، ر. س. شافوليمو(١،٣)، أ. ج. دى بور(١،٢) و هـ. أ. فتزهو(١،٢)

(١) البرنامج التعاوني لدعم أبحاث المجترات الصغيرة، ص ب (٢٥٢)، ماسينو، كينيا، (٢) وينروك انترناشونال، موريلتون، أركنساس ٩٥٣٧ — ٧٢١١٠، الولايات المتحدة الامريكية، و (٣) وزارة الزراعة وتنمية المواشي، نيروبي، كينيا.

الخلاصة: ان الهدف من البرنامج التعاوني لدعم أبحاث المجترات الصغيرة بكينيا هو تطوير وتقييم نظم انتاج الماعز ثنائي الغرض (لبن — لحم) لدى المزارعين ذوي الموارد المحدودة. هذا ويتم تنفيذ أبحاث النظم الزراعية بواسطة فريق يضم مجموعة من الباحثين في تخصصات مختلفة. شملت المرحلة الأولى من البرنامج التعريف بالنظم الزراعية المستهدفة اضافة الى المكون البحثي في المحطات التابعة للمشروع. أما المرحلة الثانية فقد شهدت خليطاً من أبحاث المحطات والتجارب الحقلية التي يشرف على ادارتها الباحثون. وستشتمل المرحلة الثالثة على رصد موسع في مزارع نظم انتاج الماعز ثنائي الغرض التي أسست وفق حزم تقنية تم اعدادها في المرحلة الثانية.

(Peste des petits Ruminants) أحد الأمراض الخطيرة التي تصيب المجترات الصغيرة في المناطق الاستوائية وهذا يعني ان دور المركز الاساسي ينحصر في رصد وتقييم زراعة الأشجار في الحقول تحت أنماط ادارية مختلفة وفي ظروف بيئية متعددة .

لقد تمت مناقشة المنهجية التي احتيرت لاجراء مثل هذا النوع من الأبحاث وأبرزت المشاكل الهامة الى جانب الفرص المتاحة . وتشير النتائج الأولية الى أنه إذا ما تم اختيار المداخل المناسبة وقدمت الاقتراحات الوثيقة الصلة بالمزارعين فإن هذا يولد لديهم الرغبة والاستعداد لتجربة الأفكار الجديدة حتى ولو لم تكن هنالك فائدة ترجى . هذا وقد تم تقديم بعض الاقتراحات فيما يختص بطبيعة وتحليل المعلومات التي تم الحصول عليها من هذا المشروع .

استجابة المزارعين لثلاثة أعلاف صيفية في دلتا نهر النيل

إ. م. سليمان(١) ، **إ. أ. خفاجي**(١) ، **م. ص. يوسف**(١)، **م. ك. حنحوت**(١) **وأ. أ. موسى**(٢)

(١) معهد أبحاث الانتاج الحيواني، مركز البحوث الزراعية، وزارة الزراعة، الدقي، الجيزة، مصر، و (٢) معهد أبحاث الاقتصاد الزراعي والاحصاء، الدقي، الجيزة، مصر .

الخلاصة : أجريت هذه الدراسة التي شملت واحد وثلاثين مزرعة صغيرة في مركزين بمحافظة المنوفية وذلك لتقييم أداء كل من علف الفيل والسوردان الذين تم ادخالهما حديثا مقارنة بالدراوة التي تمثل العلف التقليدي بالمنطقة . وقد قيّمت هذه الأعلاف من حيث الانتاجية والقيمة الغذائية اضافة لعائدها الاقتصادي . هذا، وبينما تمثل المساحة المزروعة بالدراوة حوالي نصف مساحة الأعلاف الصيفية المختارة للدراسة نجد أن علف الفيل والسوردان يقتسمان المساحة المتبقية .

أشارت النتائج الى أن متوسط انتاجية الهكتار (واحد هكتار = ٢٫٣٨ فدان) من العلف الاخضر بلغت ٢٠٨٫١٩ و ١٣٩٫٥٠ و ٥٧٫٢١ طن لكل من علف الفيل والسوردان والدراوة على التوالي بينما بلغ متوسط انتاجية المادة الجافة ٣٧٫٦٧ و ٣٤٫٦٠ و ١٤٫١٩ طن بذات الترتيب الآنف ذكره. أيضا، فقد أوجد التحليل الكيمائي للمادة الجافة أن متوسط النسب المئوية للبروتين الخام

تحت ظروف المنتج المحلية وهذه التجارب تكتسب قيمة خاصة بالنسبة للابتكارات التي تمثّل انحرافاً كبيراً عن الممارسات التقليدية ومفاهيم الادارة . وأهم مميزات التجارب التي يشرف على تنفيذها الباحثون هي انخفاض عنصر المخاطرة لدى المنتج وتعريض المجموعة المستهدفة للتقنية الحديثة مبكراً وسهولة التقييم الكمي للنتائج عن طريق تحكم أكثر في ظروف التجارب . أما التجارب التي ينفذها المنتجون أنفسهم فيجب أن تركز على التقنيات التي تم اختبارها من قبل بدلاً من ادخال تقنيات غير مألوفة والتي يكون من العسير على المنتج استشعار فوائدها .

طريقة لتطوير التجارب الحقلية : مشروع رائد لتحسين إنتاج المجترات الصغيرة في المناطق الرطبة بغرب افريقيا

أكوسى أتا — كراه

برنامج المجترات الصغيرة، مركز المواشي الدولي لأفريقيا (إلكا)،
ب م ن ٥٣٢٠ ، عبادان ، نيجيريا

الخلاصة : تمثل التجارب الحقلية جزءاً مكملاً لاستراتيجية البحث الخاص ببرنامج المجترات الصغيرة بمركز المواشي الدولي لافريقيا (إلكا) نسبة لأنها توفر المعلومات والأفكار التي تقنّن وتعزز ادخال الابتكارات المناسبة على نظم انتاج المجترات الصغيرة وزراعة الأشجار الرعوية جنباً الى المحاصيل الحقلية تقف مثالاً على ذلك حيث أن ادخال زراعة الأشجار الرعوية على شكل مجازات ضيقة داخل الحقل يؤدي الى تحسين انتاج المجترات الصغيرة من خلال خلق صلة وثيقة بينها وبين انتاج المحاصيل عن طريق استعمال الأشجار البقلية سريعة النمو كعلف للحيوانات وكغطاء عضوي واق للتربة .

لقد تم تحليل تطور التجارب الحقلية الخاصة بادخال زراعة الأشجار الرعوية على النحو المذكور آنفاً منذ أن ابتدأت الزراعة لأول مرة عام ١٩٨٠ بواسطة انشاء مشروع حكومي رائد لزراعة هذه الاشجار بالحقول في عام ١٩٨٤ . وهذا المشروع الرائد الذي هو محور هذه الدراسة قد تم تنفيذه في حقول (٨٦) مزارعاً وعلى حيواناتهم . هذا، وقد اقتصر دور مركز المواشي الدولي لافريقيا على توفير الشجيرات الرعوية وتقديم مقترحات بشأن الزراعة والادارة اضافة لتطعيم الحيوانات ضد

المستهلك بواسطة الحيوانات ومستوى أدائها اضافة الى تكوين العلائق الكيمائي وتكاليف اعدادها بما في ذلك العمالة والترحيل .

حللت النتائج احصائياً بواسطة تحليل التباين كما حللت اقتصادياً عن طريق الميزانية الجزئية وتحليل الحساسية . وقد أظهرت النتائج تفوق العلائق التي تعتمد على المخلفات الزراعية مقارنة بالمركزات العلفية . ومما يجدر ذكره أن المزارعين قد أبدوا تجاوباً وتعاوناً تاماً وشاركوا مشاركة فعالة في تنفيذ هذه التجارب .

استعمال الأعلاف المحفوظة لتغذية الماشية التقليدية في جبال النوبة بالسودان

و . ترنت بندرسون و ريتشارد هـ . كوك

مشروع تطوير البحوث الزراعية لغرب السودان ، هيئة البحوث الزراعية ،
ص . ب (٥١٤١) ، الخرطوم جنوب ، السودان

الخلاصة : تسمح التجارب داخل القطعان باختبار التقنيات الواعدة تحت ظروف المنتجين وفي ذات الوقت تجسد لهم الفوائد التي يمكن تحقيقها بتبنّيهم للتقنية . ان تجارب استعمال الدريس في تغذية الحيوان التي نفذت بواسطة مشروع تطوير البحوث الزراعية لغرب السودان لخدمة منتجي المواشي سواء المقيمين منهم أو المتنقلين قد تمخضت عنها رؤى هامة عن طرق ومشاكل تصميم وتنفيذ التجارب داخل القطعان لدى مجموعات متباينة من المنتجين .

تشير الخبرة في مشروع تطوير البحوث الزراعية لغرب السودان الى أنه يمكن تقسيم التجارب المنفذة على مسستوى المنتجين الى قسمين رئيسيين : (أ) التجارب التي يشرف على ادارتها ويتحكم فيها الباحثون ولكن باستعمال حيوانات أو أراضي المنتجين و (ب) التجارب التي يقوم بادارتها المنتجون والتي قد تشمل ممارسات مقترحة لادارة التقنية ولكن يبقى قرار التنفيذ في يد المنتج وحده . ان الغرض الأساسي من اجراء النوع الأول من التجارب هو تقييم التقنيات التي لم يتم اختبارها

الخلاصات

مسح استطلاعي وتجارب حقلية
في حظائر تسمين الماشية الخاصة بمنطقة الخرطوم

سعد المدني أحمد(١) ، تاج السر أحمد محمد(٢) ، ومحجوب جعفر الحاج(٢) .

(١) شعبة الاقتصاد الزراعي ، كلية الزراعة ، و(٢) شعبة تغذية الحيوان ، معهد الانتاج الحيواني ، جامعة الخرطوم ، ص . ب ٣٢ ، الخرطوم ، السودان

الخلاصة : يهدف هذا البحث لادخال تقنية خافضة للتكلفة عن طريق الاستفادة القصوى من مخلفات التصنيع الزراعي في تسمين الماشية بالسودان علماً بأن الطريقة التقليدية المتبعة في عمليات التسمين هذه تعتمد كلياً على العلائق المركزة ذات التكلفة المرتفعة . عليه فقد قام فريق الباحثين المكون من خبير في الاقتصاد الزراعي وخبيرين في تغذية الحيوان باجراء مسح استطلاعي شمل كل حظائر التسمين الخاصة في منطقة الخرطوم بهدف فهم الكيفية التي تتم بها تغذية الأبقار ولاختيار المواقع المناسبة لتنفيذ التجارب الحقلية ثم حللت نتائج المسح الاستطلاعي عن طريق العمليات الحسابية البسيطة والاحصائيات الوصفية (توزيع التواتر أساساً) .

بناء على نتائج المسح الاستطلاعي وبتعاون المالكين تم اختيار موقعين لاجراء التجارب . أما المعاملات فقد تضمنت نوعين من العلائق التي تمت تجربتهما من قبل بواسطة الباحثين ويعتمدان في تكوينهما على المخلفات الزراعية ، اذ تعتمد العليقة الأولى على قشرة الفول السوداني بنسبة خمس وعشرين بالمائة وتعتمد الثانية على قش الذرة بنفس النسبة مقارنة بالعليقة التقليدية والتي تتكون من المركزات العلفية . استمرت التجربة لمدة سبع وستين يوماً تم خلالها رصد وقياس كمية العلف

الحالات لا تستطيع التجارب المخبرية أو تلك في محطة البحث أن توفر سوى القليل من المعلومات عن ملاءمة التقنية الحديثة للنظام الزراعي المستهدف .

أيضاً كانت هنالك نقطة اجماع عن الحاجة الى تنقية التقنيات الحديثة قبل اطّلاع المزارعين عليها . ويمكن لعملية التنقية هذه أن تشمل المسوحات الاستطلاعية والتجارب التشخيصية لدراسة الممارسات الحقلية الحالية والظروف السائدة كما يجب أن تشمل أيضاً تحليلاً اقتصادياً أوّلياً باستعمال أحسن المعلومات المتوفرة لتقدير امكانيات مربحية التقنية الحديثة من وجهة نظر المزارع اضافة الى تأثيراتها على المنطقة . وسيقود هذا الاجراء الى التركيز المبكر على أجود إمكانيات التحسين من حيث الفوائد الفردية والتأثير الاقليمي .

لقد استشعرت الحاجة لتعريفات أوضح للمشاكل البحثية وعرض أدق للأهداف . واعتماداً على الأهداف المعنّية يمكن أن يتم تصميم وتنفيذ وتقييم التجارب الحقلية للثروة الحيوانية كأجزاء أصلية من (١) التشخيص أو ، (٢) التصميم أو ، (٣) الاختبار أو ، (٤) الارشاد لأبحاث النظم الزراعية وعملية التنمية .

لقد كان هنالك اجماعاً بأن التجارب الحقلية للثروة الحيوانية لن تكون أبداً بديلاً عن التجارب المخبرية أو التجارب في محطات البحوث ، بل ان التجارب الحقلية للثروة الحيوانية تظهر كواجهة تكميلية تبشر بأنها ستصبح أكثر معرفة بل أداة روتينية لدى برامج البحوث الوطنية في المستقبل وذلك نسبة لفعاليتها في معالجة أنواع خاصة من المشاكل وبالأخص التساؤلات التي تدور حول تقبّل المزارعين للتقنيات الحديثة .

المحررون : توماس ل . نوردبلوم /ايكاردا
عوض الكريم حامد أحمد /جامعة الجزيرة
جوردون ر . بوطس / آي دي آر سي

لقد كان المصدر الرئيسي لجميع الدراسات التي قدمت في الحلقة الدراسية أبحاثاً أجريت بالتعاون مع المزارعين وعلى أراضيهم وباستعمال عمالتهم وفي أغلب الحالات حيواناتهم وأعلافهم . لقد برهن الأشخاص الذين يمارسون اجراء التجارب الحقلية للثروة الحيوانية على براعتهم الفائقة وسعة حيلتهم في كل من أعمالهم الحقلية وفي تدوين خبراتهم . فقد توجب عليهم الارتجال ليس فقط عند اجراء البحث ولكن أيضاً عند ايجاد التعابير والتعريفات لوصف أبحاثهم تلك . وفي أغلب الحالات تم اجراء الدراسات البحثية المجمعة هنا بمعزل عن بعضها البعض . وعليه فقد يلاحظ القارىء عدم وجود اصطلاحات مشتركة لمعالم تشترك فيها الدراسات بصورة حقيقية . كل هذه الحقائق تؤكد ثانية على وجود طرق بحثية في مراحل نموّها الأولى .

اضافة الى تجميع اثني عشر دراسة أعدّت بواسطة علماء هم الروّاد الأوائل للتجارب الحقلية للثروة الحيوانية — كل في وطنه — فقد أتاحت الحلقة الدراسية لعدد منهم لقاء بعضهم البعض ومناقشة أفكارهم بالتفصيل . وقد شارك في الحلقة الدراسية مؤلف واحد فقط من كل دراسة على وجه العموم .

لقد وافق خمسة من المشاركين على القيام بمهمة المناقشة وتجميع الآراء والأفكار حيث أوكلت لكل واحد منهم مسؤولية قراءة كل الدراسات بعناية والعمل كمستمعين رئيسيين في كل المناقشات وقيادة مجموعات عمل صغيرة لمناقشة مواضيع محددة عن طرق التجارب الحقلية للثروة الحيوانية .

وفي اليوم الختامي قدّم كل واحد منهم تقريراً عن موضوع اتفق عليه من قبل وذلك بحضور جميع المشاركين في الحلقة الدراسية . ولقد لمست أغلب الدراسات كل من مواضيع منهجية البحوث الخمس مما أتاح فرصة البداية الممتازة لمناقشات موضوعية وحيّة بين المشاركين . وسيفيد القارىء من الأفكار التي تم تجميعها وضمّنت في خمس ملخصات عن : (١) تعريف المشاكل البحثية (كنبشير) ، (٢) تصميم التجارب الحقلية (فان آيز) ، (٣) مشاركة المزارع في التجارب الحقلية للثروة الحيوانية (كاتيقيل) ، (٤) أسس التقييم (كوك) ، و(٥) اتجاهات التجارب المستقبلية (أندرسون) .

ورغم اختلاف آراء المشاركين الا أنه كان هنالك اجماعاً على فائدة التجارب الحقلية للثروة الحيوانية في بعض التطبيقات خاصة بالنسبة للتجارب التي تظهر فيها تفاعلات هامة بين الطريقة الحديثة ومظاهر البيئة الحقلية الأخرى . ففي هذه

(ب) اتجاهات تخطيط التجارب في المستقبل ، والبيانات العملية والتغيرات السياسية : مامدى ملاءمة النتائج لمجموعة المزارعين المستهدفة والمحددة من قبل ؟

(ج) ملاحظات المؤلفين عن مجال وموقع وتكلفة وجودة وقيمة البحث : ماهي السمات التي يمكن تحسينها وكيف ؟

وبطبيعة الحال فقد اختلفت معاملة النقاط المذكورة أعلاه بين الاثني عشر دراسة نسبة لاختلاف البحوث التي قدمت من حيث الهدف والمجال .

لقد كان مقصد الحلقة الدراسية الأصلي التركيز على التجارب الحقلية للثروة الحيوانية بتعريفها الضيق نسبيا الذي يعني اجراء تجارب البحوث البيولوجية في حقول المزارعين وبمشاركتهم . ورغماً عن أن العديد من الدراسات أجريت وفقاً لهذا التعريف الا أن بعضاً منها أورد تعريفات أوسع : كبيان عملي لتقنية الثروة الحيوانية وكحزمة كاملة لمكوّن بحثي للثروة الحيوانية موجهاً نحو نظام معيّن وكوسيلة ارشاد يتم عن طريقها نشر التقنية على أكبر عدد ممكن من المنتفعين . ان مدى التعريفات (محددة كانت أم ضمنية) التي وجدت في الاثني عشر دراسة تدل على أن هنالك طريقة بحث في أطوار نموها الأولي .

كذلك تؤكد الدراسات على وجود مدى واسع للمشاكل البحثية ونظم انتاج الثروة الحيوانية التي يمكن التعرض اليها عن طريق التجارب الحقلية . لقد قدمت دراستان عن تجارب التغذية في حظائر تسمين الماشية التجارية (أحمد ، محمد والحاج ، ونور وحمزة) كما ركزت دراستان على ادخال محاصيل علفية جديدة لتغذية الماشية (سليمان وآخرين ، ومضوى وآخرين) . وكما اختصت دراستان أخرتان بالنظر في انتاج واستعمال الأعلاف المطرية (بندرسون وكوك ، وتلي وآخرين) فقد عنيت ثلاث دراسات بابتكارات استخدام وادارة والتحكم التجريبي في الثروة الحيوانية : استخدام ماشية الألبان المهجنة للجر في أثيوبيا (قريسيلز وأندرسون) ، الماعز ثنائي الغرض في غرب كينيا (سيد أحمد وآخرين) وتجارب النظم الرعوية الانتشارية باستخدام قطعان الماشية المترحلة بالسودان (فضل الله وكوك) . أخيراً ، أوردت ثلاث دراسات اختبار مدخلات جديدة في النظام الزراعي : زراعة الأشجار البقلية بجانب المحاصيل واستعمالها كعلف للماعز في نيجيريا (أتا — كراه) ، اضافة العناصر المعدنية لغذاء الماعز بغرب جاوا بأندونيسيا (فان آيز وآخرين) ، ومعاملة القش بالأمونيا لتغذية الماشية بمصر (ياقوت وآخرين) .

مقدمة

إن الغرض من اصدار هذا الكتيب هو تسهيل تبادل الأفكار والخبرات بين العلماء العاملين مع البرامج القومية في الشرق الأوسط وأفريقيا والمناطق الأخرى والذين لديهم الرغبة في التجارب الحقلية للثروة الحيوانية عن طريق التعاون المباشر مع المزارعين . ويتألف هذا الكتيب من اثني عشر حالة دراسية عن مواضيع بحث محددة بالإضافة إلى خمس ملخصات لمنهجية البحوث .

لقد طلب إلى المؤلفين أن يركّزوا على الافادة عن الكيفية التي تم بها تصميم وتنفيذ وتقييم تجاربهم الحقلية للثروة الحيوانية بحيث يتم أولاً التعريف بالمشكلة البحثية ولماذا تمت دراستها وأي مجموعة من المزارعين تتأثر بها ثم بعد ذلك يوضحوا بالتحديد سمات طرقهم التالي ذكرها :

(أ) تحديد واختيار المزارعين ومواقع الحقول التي أجري فيها البحث .
(ب) تصميم التجربة ويشمل : حجم القطع التجريبية ، أعداد وأصناف الحيوانات ، والفترة الزمنية للبحث في إطار النمط الحولي للانتاج .
(ج) ملكية وحماية والتحكم اليومي في الحيوانات والقطع الحقلية .
(د) المقاييس الحقلية : كيف تم أخذها وكم مرة أخذت ومن قام بهذا العمل .
(هـ) أسس تعويضات المزارعين المتعاونين .
(و) كيف تم تسجيل واستخدام ردود فعل المزارعين وملاحظاتهم وآرائهم .
(ز) احتياجات البحث الحقلي وتشمل : العمالة ، العربات والمعدات الاخرى أو متطلبات المدخلات .

ومن بعد وصف طرقهم البحثية طلب الى المؤلفين أن يوضحوا في إيجاز النتائج التي تحصلوا عليها على أن تشمل النقاط التالية :

(أ) مؤشرات البحث الرئيسية المتعلقة بمقارنات قياسات الحقل الكمية ، والنتائج الأقتصادية ، ووجهة نظر المزارعين عنهما . هل يمكن للمزارعين أن يحققوا مربحية بتبنّيهم للأسلوب الجديد ؟

لقد تم إصدار هذا المجلّد من الحالات الدراسية ومناقشات المنهجية بهدف تسهيل عرض الأفكار ولزيادة سرعة الاتصال عن طرق التجارب الحقلية للثروة الحيوانية بين العلماء في منطقة الشرق الأوسط وإفريقيا على وجه الخصوص . وإمعاناً في تحقيق هذه الأهداف فقد تم نقل خلاصات الأثني عشر دراسة وكل ملخصات منهجية البحوث إلى اللغة العربية وضمّنت في هذا المجلد . ولقد تلقى الدكتور عوض الكريم حامد أحمد المحرر المسؤول عن الترجمة بالعربية في هذا المجلّد مساعدات قيمة من الدكتور محمد بخيت سعيد والأساتذة فايق بحّادي ومحمود عقلة من المركز الدولي للبحوث الزراعية في المناطق الجافة (إيكاردا) ومن الدكتور نبيل إبراهيم حسين من المركز العربي لدراسات المناطق الجافة والأراضي القاحلة (اكساد) . الشكر موصول أيضاً للآنسة ضياء مفتي (إيكاردا) لطباعتها عدة مسودات باللغة العربية .

إن إقامة هذه الحلقة الدراسية عن التجارب الحقلية للثروة الحيوانية وإصدار هذا الكتيب يعكسان التعاون الفعال والمستمر بين مركز البحوث للتنمية الدولية (آي دي آر سي) والمركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا) . لقد ساعد الدكتور إيوان تومسون (إيكاردا) المنظمين كثيرا بمدهم بأفكار عن إقامة الحلقة ومراجعة مسودات الأوراق المقدمة . كذلك نتقدم بالتقدير الخاص للدكتور جيمس رايلي من مشروع تطوير البحوث الزراعية لغرب السودان (الخرطوم ، السودان) لنصيحته القيمة التي كان لها أكبر الأثر في التعريف المبكر بالحلقة الدراسية . أخيراً الشكر لكل المنظمات الدولية التالي ذكرها لمساهمتها في تمويل اشتراك العاملين فيها وهي : برنامج دعم النظم الزراعية (فلوريدا ، الولايات المتحدة الأمريكية) ، مركز المواشي الدولي لأفريقيا (أديس أبابا ، أثيوبيا) ، وينروك انترناشونال (أركنساس ، الولايات المتحدة الأمريكية) ، مشروع تطوير البحوث الزراعية لغرب السودان والبرنامج التعاوني لدعم أبحاث المجترات الصغيرة (جامعة ولاية كارولينا الشمالية ، برنامج المعونة ، الولايات المتحدة الأمريكية) .

إن هذه الجهود التعاونية تمثل إشارة قوية للعزيمة المخلصة والرغبة العلمية المشتركة .

هـ . د . زاندسترا
مدير
قسم علوم الزراعة والأغذية والتغذية
مركز البحوث للتنمية الدولية

(إيكاردا) من خلال تعاملهما مع البرامج الوطنية للبحوث الزراعية في مناطق الشرق الأوسط وأفريقيا عدداً من العلماء الوطنيين الذين اقتنعوا بالحاجة لإجراء بعض أبحاث الثروة الحيوانية في تعاون مباشر مع المزارعين . ونسبة لحماس هؤلاء العلماء وتعدد الطرق والمصطلحات التي يستعملونها فقد انبثقت فكرة جمعهم لدراسة مشاكل الطرق البحثية التي تهم الجميع .

ولتسهيل الاتصالات المهنية بين العلماء القوميين الذي كانوا يعملون من قبل في عزلة واقعية عن بعضهم البعض فقد طلب من المشاركين في الحلقة الدراسية أن يسجلوا طرقهم البحثية في دراسات رسمية على أن تحوي كل دراسة نفس سمات ومظاهر الطرق البحثية وذلك في إطار الموضوع المعيّن للبحث الحقلي للثروة الحيوانية . لقد تم تشجيع التأليف الجماعي من حيث تعدد التخصصات وتم تحقيقه بصورة جيدة في أغلب الدراسات مما أضاف كثيراً إلى قيمة الحلقة الدراسية رغماً عن أن فرصة المشاركة المباشرة قد أتيحت لمؤلف واحد فقط من كل دراسة . إن مساهمة كل المؤلفين الذين كتبت أسماؤهم بجانب عناوين دراساتهم التي يضمها هذا الكتيب جديرة بكل تقدير .

لقد تم التخطيط لاعداد ملخّصات عبر الأوراق التي قدمت بحيث يعنى كل ملخص بسمة واحدة من السمات الرئيسية لمنهجية البحوث بقصد رصد قوة وضعف التجارب الحقلية للثروة الحيوانية بالإضافة إلى إمكانياتها . ولقد تطوع خمس مناقشين للقيام بهذه المهمة حيث تحتم على كل واحد منهم قراءة اثني عشر دراسة وتجميع التعليقات التي دارت عن كل واحدة منها خلال جلسات المناقشات . لقد استحق هؤلاء الأشخاص كل الشكر نسبة لجهودهم كما لا بد من تسميتهم وهم : هندريك كنبشير ، جان فان آيز ، جاكسون كاتيفيل ، ريتشارد كوك وفرانك اندرسون .

وبما أن طرق التجارب الحقلية للثروة الحيوانية تمثل واجهة تكميلية للبحوث فإنها تبدو متميزة ومتفوقة على الطرق الأخرى عند بروز الأسئلة التي تدور حول تفاعلات المواشي في نظام زراعي معين أو حول تقبل المزارعين لتقنيات الثروة الحيوانية الحديثة . ونظراً لكل هذه المميزات فإنه من المتوقع أن تنشأ هذه الطرق وتستعمل في المستقبل بواسطة أعداد متزايدة من برامج البحوث الوطنية . وستسير هذه التوقعات حثيثاً حتى تصبح واقعاً ملموساً عندما يتعرف الباحثون الوطنيون ومديرو البحوث على إمكانيات هذه الطرق .

تقديم

تلعب الثروة الحيوانية دوراً متكاملاً في أغلب النظم الزراعية نسبة لاستعمالها للموارد ومخلفات المحاصيل التي ليس من الممكن استعمالها عند غياب هذه الثروة . إن التعقيدات التي تصاحب تكامل الثروة الحيوانية غالباً ما تقود إلى صعوبات في التنبؤ بتأثيرات « التحسينات » المقترحة . وبما أنه يمكن اختبار الطرق الفنية في بيئات مخبرية أو في محطات البحوث بقدر كبير من الفعالية والتحكم إلا أن الطريق الذي يجب أن تسلكه نتائج الأبحاث الواعدة لتحقيق هدف التطبيق الاقتصادي بواسطة المزارعين محفوف بالمخاطر والصعوبات . فقد أوجدت برامج البحث والإرشاد الوطنية أن المزارعين يواجهون معوقات عملية تجعل من تبنّي « التحسينات » المرئية مهمة مستحيلة أو غير مربحة .

وتعتبر المسوحات، الحقلية التي تشمل التكاليف والمعوقات التي تواجه مجموعات المزارعين المستهدفة وسائل قيّمة لتوفير المعلومات التي تبنى عليها تصميمات البحوث لتحقيق أهداف التنمية القومية . علاوة على ذلك فإن نتائج أبحاث المختبرات ومحطات البحوث قد تتطلب إجراء إختبارات حقلية قبل اقتراحها للمزارعين حتى ولو استخدمت بيانات المسح الحقلي في تصميم هذه الأبحاث . عليه فإن التجارب الحقلية للثروة الحيوانية تمثل واجهة تكميلية للبحوث وتكون بمثابة الجسر الذي يربط بين العمل المخبري المتحكم فيه والتبنّي الناجح للتحسينات الحقيقية في إنتاج الثروة الحيوانية .

يقوم مركز البحوث للتنمية الدولية (آي دي آر سي) بدعم برامج فردية لأبحاث الثروة الحيوانية في مناطق الشرق الأوسط وشمال إفريقيا منذ عام ١٩٧٦ وبصورة ملحوظة في السودان ومصر وتونس . وتعتبر هذه البحوث مكمّلة وموازية للجهود التي تبذل في أمريكا اللاتينية وشرق أفريقيا وجنوب شرق آسيا . لقد وجد مركز البحوث للتنمية الدولية والمركز الدولي للبحوث الزراعية في المناطق الجافة

المحتويات

تقديم أ
مقدمة هـ
الخلاصات ١
ملخصات منهجية البحوث ١٤
  تعريف المشاكل البحثية — هـ . كنبشير ١٤
  تصميم التجارب الحقلية — ج . إ . فان آيز ١٩
  درجة مشاركة المزارعين — ج . كاتيڤيل ٢٥
  أسس التقييم — ر . كوك ٣٢
  إتجاهات التجارب المستقبلية — ف . أندرسون ٣٧

تمهيد

يحتوي هذا الكتيب على إثني عشر دراسة تصف بعض الطرق التي استعملت في اجراء التجارب الحقلية للثروة الحيوانية . وقد تمركزت الغالبية العظمى من هذه الدراسات في مناطق الشرق الأوسط وافريقيا . كذلك يتضمن الكتيب على خمس ملخصات لمنهجية البحوث التي تمت مناقشتها في هذه الحلقة الدراسية عن التجارب الحقلية للثروة الحيوانية وتشمل : (١) تعريف المشاكل البحثية و(٢) تصميم التجارب الحقلية و(٣) درجة مشاركة المزارع و(٤) أسس التقييم و(٥) اتجاهات التجارب المستقبلية . لقد بلغ عدد المؤلفين والمؤلفين المشاركين تسعاً وثلاثين اشتركوا جميعهم في فرق بحث تعتمد على تعدد التخصصات وعملوا كعلماء اجتماع وأحياء في إجراء أبحاث عن الثروة الحيوانية في تعاون مباشر مع المزارعين . وكما اختلفت أنواع الحيوانات المعنيّة (أغنام أو ماعز أو ماشية لحوم أو ماشية ألبان) فإن سبل الانتاج قد اختلفت أيضاً (حقل أو حظيرة أو مرعى مشاع) في كل الدراسات غير أنها جميعاً ركّزت على استعمال طرق بحثية لاختبار التقنيات الحديثة عن طريق التجارب الحقلية . لقد كان هنالك اجماع يقضي بأن التجارب الحقلية للثروة الحيوانية لن تكون أبداً بديلاً عن أبحاث الثروة الحيوانية بالمختبرات أو بمحطات البحوث بل إن هذه التجارب تمثل بحثاً تكميلياً يمكن استعماله على أحسن الوجوه عندما تبرز تساؤلات حول تفاعل الحيوانات مع البيئات الزراعية أو عن مدى تقبل المزارعين للتقنيات الحديثة للثروة الحيوانية .

IDRC-242e

الطرق البحثية المستعملة
في
التجارب الحقلية للثروة الحيوانية

وقائع الحلقة الدراسية التي عقدت بمدينة
حلب — سورية
من ٢٥ إلى ٢٨ آذار (مارس) ١٩٨٥

المحررون : توماس ل . نوردبلوم ، عوض الكريم حامد احمد ،
وجوردون ر . بوطس

مركز البحوث للتنمية الدولية (آي دي آر سي)
المركز الدولي للبحوث الزراعية في المناطق الجافة
(ايكاردا)